POWER PLANT ENGINEERING

CONTENTS FOR THE MONTH OF

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Cover: Flames leap high into the sky at night as steel production goes forward at the south works of the Carnegie-Illinois Steel Corporation Plant at South Chicago. Photo, Carnegie-Ill. Steel Corp.

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Assembling the coils on a 13,200-v., 7500 kv-a. synchronous condenser in the East Pittsburgh shops of the Westinghouse Electric & Mfg. Co.

Putting In The Throw

"PUTTING in the throw" is what the skilled craftsmen who assemble electrical equipment call this operation of fitting the insulated copper coils in the grooves of an armature. Despite the massiveness of the conductors and the great strength of the resulting structure, it is delicate work and calls for skill and care. These elements —the skill, the care, the knowledge and experience—are not apparent to the unpracticed eye in the finished machine but they contribute, even more than the quality of the materials used, to the reliability and efficiency of the finished machine. This is perhaps true of electrical machinery where unseen voltages are forever present to attack vulnerable spots in the insulation, than in the case of non-electrical machinery. These men represent what is usually referred to as skilled labor but they are to a certain extent artists as well, for the configuration of the coils are laminations they weave into a finished machine make as attractive a design as many woven into a piece of tapestry. Theirs is a functional design in the parlance of modern art.

WITH THE EDITORS

Junk the Power Plants, Here Comes U-235

MUCH PUBLICITY has been given recently to the newly isolated isotope of Uranium which goes by the intriguing name of U-235. It sounds like one of Mr. Hitler's submarines but, according to the feature writers, Mr. Hitler's submarines won't be worth a tinker's dam when the scientists get hold of a pound of U-235. A pound of this stuff will do wonders,—it will fry several million hamburgers or blow the combined navies of England, France and Italy for a row of totalitarian ash cans, all according to the feature writers.

The only problem is, how to get a pound of U-235. So far the most anybody has been able to obtain has scarcely been enough to put in a gnat's ear. At the General Electric Co., Drs. Kingdon and Pollock recently isolated a large amount—about one hundred-millionth of a gram—a thirty billionth of a pound. This was a lot—enough to shout about in fact.

All this is interesting from a scientific standpoint but the predictions are a bit tiresome. According to one newspaper report all that was necessary was to put the U-235 in water and instantly we would have unlimited power. Scrap the power plants at once.

As "Electronics" points out in the June issue, "no one as yet has supplied atomic energy to push a dead fly across a frictionless surface. Atomic energy always seems to be one jump ahead of the scientists —they always need a bigger jimmy, and having got the jimmy the vision of releasing energy is just as bright but is only delayed a bit longer."

There is no need of these rosy pictures of what U-235 will do in the future, the mere fact that they have been able to isolate it is interesting enough. Knowledge about how things are made out of the ultimate building blocks of nature is a sufficient excuse for indulging in these researches. Scientists need not kid us along with these promises of something utilitarian. Quoting again from "Electronics," "Can we Americans never enjoy beauty, or knowledge, or any esthetic qualities without wanting to know how much the thing costs, or what we are going to get out of it."

These also are our sentiments.

Legal Simplicity

THE WAYS of the lawyers are strange and often baffling to the engineering mind. Between the whereases and the wherefores and the parties of first part and the parties of the second and steenth part are many pitfalls which the engineer sweeps aside with a phrase but the lawyer has to build a bridge over each one. An engineer friend, one employed by one of our larger utility corporations, was telling us of his troubles with the lawyers. He related of having written an engineering contract of some sort which when it was finished was approved by the engineering department as being concise and very much to the point. Everything seemed lovely and the whole thing came to only one and a half pages of typewriting.

So it was submitted to the legal department and after studying it for several days, a conference was called. The contract seemed to cover the case, said the lawyers, but it was too complex—it should be simplified. Naturally, this suggestion met with the approval of the engineers; if the thing could be simplified, by all means let it be simplified. So the lawyers took it in hand and after another week's work they produced the simplified version. It ran 17 pages!

Aha! Now We Have Vanishing Cream for Engineers

IN LINE with the plans for "a new order" is the recent announcement of cosmetics for the engineer worker. Milady is not the only one who will henceforth apply her makeup before she starts out on her day's duties. Jim Berzak, the husky arc welder who welds sections of steel tunnel together, all will tarry in his boudoir to apply vanishing cream to his "mug." Ply No. 8 is the most recent development in industrial skin protection for welders and cutters whose work exposes them to the intense ultraviolet radiation of the electric arc. In such operations flashes occur which because of the ultraviolet radiation they contain cause severe burns. Such radiation will often penetrate several layers of clothing. If Ply No. 8 is used, welders and cutters can work with their shirts open at the chest or in scanty attire without fear of burning.

This product is applied like a vanishing cream, rubbing into the skin completely dry and invisible. Its ingredients are claimed to create a perfect barrier to the harmful rays.

Before long the welders' washroom will look like a debutante's boudoir.

Business Ahead

WHILE there has been no material reduction in output of recent months, uncertainty regarding war conditions has been a brake on further expansion especially when additional capital investment was involved. Regardless of the outcome in Europe however the domestic rearmament program is bound to be carried through and involve the expenditure of millions of dollars, largely in capital goods industry, by this time almost a chronic sufferer from the ills of the depressions.

While there has been no fanfare, the increased acceleration has been notable since the first of July by employment agencies, probably the most sensitive barometer of business conditions available. Slowly but surely the demand for men has been increasing with all indications that it will continue.

During 1939, generating stations capacity increased some 1,275,819 kw., additions scheduled during 1940 total almost 2,000,000 kw. with an additional 2,500,000 subsequent to 1940. Many, especially industrial plants, who have delayed needed power plant construction are beginning to be worried by priority talk.

THE NEW HYDRO PLANT AT SWINGING BRIDGE

A description of the Engineering Features of a novel hydroelectric development in New York state, that has been in course of development during the past 17 years. The work described refers specifically to the 5th step in the development but enough information is given to provide a picture of the project as a whole. It is a development of The Rockland Light and Power Co.

By L. G. RAPER and A. L. MIXER
Designing Engineer Electrical Engineer
Chas. T. Main, Inc., Boston, Mass.

THE ROCKLAND LIGHT AND POWER COMPANY has recently installed a 7500 kv-a., completely automatic, hydro-electric unit in a new power house at their Swinging Bridge development, located on the Mongaup River about 20 mi. north of Port Jervis, N. Y. This supplements the original 6250 kv-a. plant at this point.

At the same time, water from their Toronto storage reservoir, located on Black Lake Brook, an adjacent tributary of the Mongaup River, was made available to the Swinging Bridge plants. This was effected by raising the dam on this brook at Cliff Lake to the level of Swinging Bridge dam, and driving a tunnel about 2100 ft. long, connecting Cliff Lake and Swinging Bridge Reservoir. The water from Lebanon Lake, which is on another tributary of the Mongaup River, was also made available to the Swinging Bridge plants by excavating a channel about 5000 ft. in length between Lebanon and Cliff Lakes.

The total hydro capacity on the Mongaup River is thus raised to about 31,000 kv-a., and the kilowatt-hours output of the Swinging Bridge plant is substantially increased.

This work is the fifth step in the development of the water power of the Mongaup River in the past 17 years, to serve the territory of the Rockland Light and Power Co. between Port Jervis and Nyack, N. Y.

Although all the developments are within 75 mi. of New York City, the drainage area of the Mongaup River is almost entirely in a wild and timbered state. This has made it very favorable for hydro-electric development.

The development of the Mongaup has already involved the construction of five dams with a total height of 420 ft. and three power plants developing a total head of 425 ft. The ultimate development of the Mongaup River involves the construction of another dam and plant which will utilize 160 ft. additional head. This will make the total developed head on this river about 585 ft.

The original development at Swinging Bridge, built in 1928-29, consisted of an earth dam about 140 ft. high, creating a reservoir with a storage capacity of about 1600 million cu. ft.; a 6250 kv-a., 123 ft. head, hydro-electric unit located in a power house at the downstream toe of the dam and connected to a steel-lined concrete conduit under the dam. This plant was completely automatic, operated by remote control from the Mongaup Falls plant.

The new 7500 kv-a. unit is installed in a new power house on the west bank of the river about 150 ft. below the dam. It is connected to the reservoir through a tunnel excavated through the rock around one end of the dam.

The new power house is very similar to the first one, with concrete substructure and brick superstructure. It is a one-story building, with a small basement containing miscellaneous electrical equipment, oil heater and toilet facilities. The generator is supported above the operating floor level on a concrete pedestal 7 ft. high; the switchboard is located on the main floor above the basement, at the end of the station.

A 40-ton hand operated crane

is provided to handle the equipment.

The turbine, rated at 9500 hp. capacity at 110 ft. head, is a single runner, vertical, Francis type, with plate steel spiral and elbow type draft tube. The gross head will vary between 124 and 84 ft. The turbine is of special design, with the usual wicket gates and also a cylinder gate operating outside the wicket gates through slots in the speed ring. The runner is of welded construction with buckets of stainless steel plate and the crown and band of cast steel. The speed ring and top plate extension are of cast steel, and the top plate is of cast-iron.

The cylinder gate permits keeping the spiral full of water when the unit is shut down, without an excessive loss of water by leakage, which would occur if the wicket gates were used for this purpose. If the spiral is kept full of water, no time will be lost when starting the unit, in filling the tunnel or the spiral, as would be the case if the Broome gate in the gate shaft were used or another type of gate at the spiral intake were provided and closed whenever the unit is shut down.

The generator is a 7500 kv-a., 6750 Kw., 0.90 power factor, 3 phase, 60 cycle, 4000 colt, 240 r.p.m., vertical unit with direct connected exciter and pilot exciter. It has all the usual accessories necessary for automatic control, including an amortisseur winding. It is totally enclosed by an air discharge housing. This is connected to air ducts having thermostatically controlled dampers to regulate the room temperature. This reduces the noise in the power house and the generator windage losses.

The switchboard is a steel enclosed duplex type of control board, having semi-flush equipment. Although the plant is entirely automatic, the switchboard permits manual local control by an operator as well as remote automatic control from the Mongaup Falls plant three miles away.

The remote control is performed by a 5-point automatic supervisory equipment of the code selector type. In addition, torque balance telemetering type of load-indicating instruments are provided at Mongaup Falls to indicate operating conditions at Swinging Bridge.

To start the unit from Mongaup Falls, having previously placed the control transfer switch in the automatic position, the operator sends the starting impulse over the supervisory control. The automatic control

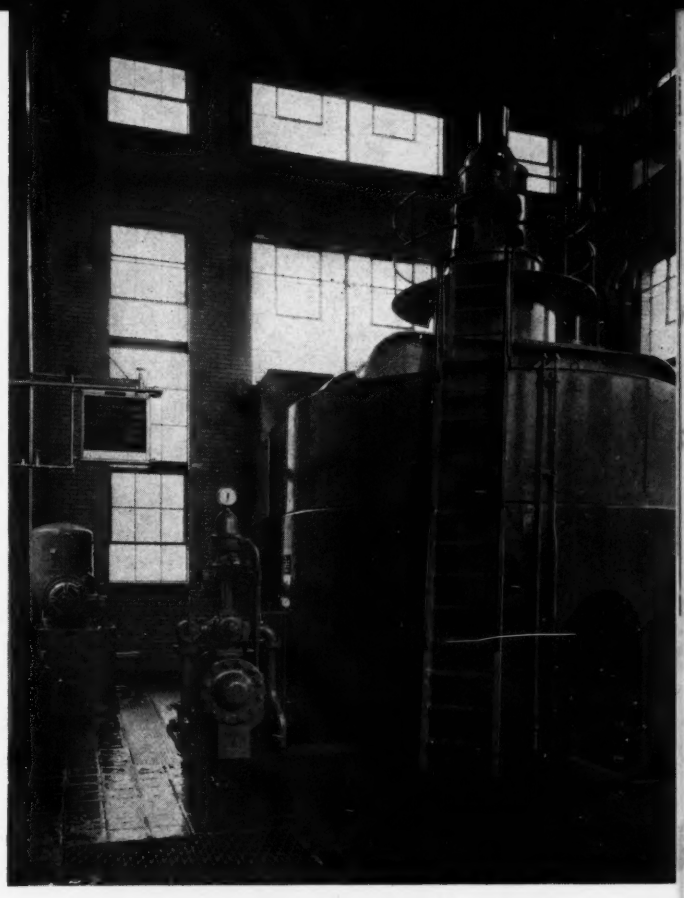


Fig. 1. Interior of Power House showing the 10,000 hp. unit

equipment then completes the operation of bringing the unit up to speed, establishing normal voltage, synchronizing and closing the line switch. The automatic snychronizing is so accurate that going on the line can only be detected by the indicating lamps on the oil switch. The load and voltage then are adjusted to the proper value by supervisory control from Mongaup Falls. Carrier current telephone service is provided for.

The main generator leads of the Swinging Bridge unit are connected solidly to a three-phase outdoor transformer adjacent to the south end of the plant. This transformer is a 7500 kv-a. oil-insulated, self-cooled non-sludging type, wound for 4000 v. delta to 66,000 v. wye.

An oil circuit breaker on the high tension side of the transformer controls the generator and transformer as one unit. This circuit breaker is a 600 amp.,

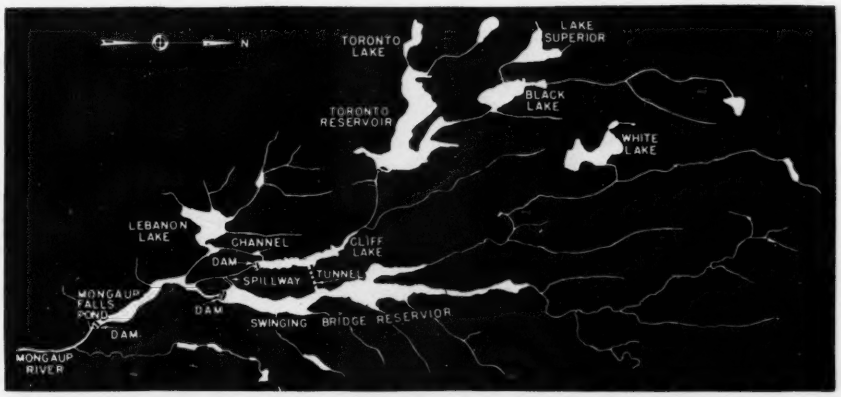


Fig. 2. Vicinity plan of the Swinging Bridge Hydroelectric Development. The new power plant is located at the end of Swinging Bridge Reservoir. The new tunnel connecting the reservoir and Cliff Lake is shown by the dotted line. This tunnel makes the water of Cliff Lake available at Swinging Bridge.

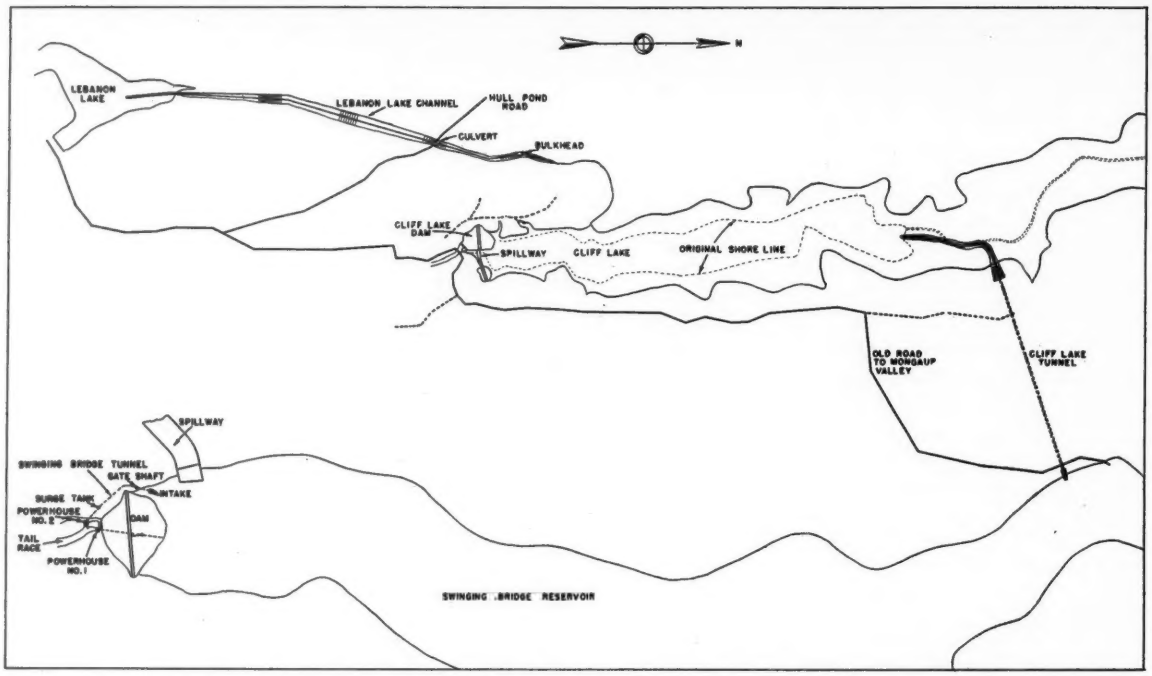


Fig. 3. General plan of the new project showing the relative location of the No. 1 and No. 2 power houses

69,000 v. breaker, having 500,000 kv-a. rupturing capacity. This, together with the potential devices, lightning arresters, line disconnects, etc., are assembled into an outdoor type transformer station adjacent to the power house.

A more detailed step by step description of the automatic starting is as follows:

The starting impulse picks up the master contactor which is a 12-pole relay initiating the operation of the various parts of the control which are given proper sequence and dependency by various mechanical and electrical interlocks as follows:

The cylinder gate is opened by oil pressure through a motor-operated pilot valve. The governor solenoid is energized next, which turns on the governor oil, releases the governor brakes, starts the governor starting timer, and opens the wicket gates. In turn, the exciter and pilot exciter build up, normal voltage is established by the voltage regulator, voltage is matched with the line, automatic synchronizing takes place and the line switch is closed. This operation is completed in about two minutes, a large part of which is taken by the opening of the cylinder gate.

The control provides for operating the generator as a synchronous condenser. This is done in such a manner that if a system disturbance occurs, the unit will automatically pick up load.

The generator is temporarily shut down by the control in the event of overspeed, low governor oil pressure, continuous overload, or short circuit.

The generator is shut down and locked out by the following:

Overheated bearing
Loss of field
Generator phase unbalance
Overvoltage
Generator winding failure
Transformer winding failure
Incomplete starting sequence

The generator cannot re-start with field on nor until the rheostat is run to the proper re-start position. It cannot start if the line is energized on one phase only.

Swinging Bridge tunnel, which conducts water from the reservoir to the power house, is a concrete-lined horseshoe section, about 10 ft. high by 10 ft. wide. The length between portals is about 825 ft., of which the lower 140 ft. is lined with 10-ft. diameter steel penstock.

The intake, equipped with coarse trash racks, is located about 250 ft. upstream from the centerline of dam. The invert was located only 55 ft. below full reservoir level, Elev. 1070, as it could thus be constructed in the dry without excessive reservoir drawdown. This permits use of the new unit through a reservoir drawdown of about 40 ft.

About 150 ft. downstream from the intake is a gate shaft, equipped with a Broome gate, 8 ft. 6 in. wide by 13 ft. high. The shaft is 12 ft. diameter and 70 ft. deep, lined with concrete.

The gate hoist is motor operated, 30 ton capacity, supported on a gantry frame, so the gate may be raised above ground level for inspection and maintenance. The hoist capacity is sufficient to operate the gate under a full unbalanced head of 50 ft., but normally the tunnel will be filled through a 30-inch diameter gate valve, to balance the pressure before the Broome gate is opened. A 24-inch diameter air vent is provided just downstream from the Broome gate.

The surge tank is about 200 ft. from the power house, on the hillside above the power house. The steel tank is 20 ft. diameter, 72 ft. high, lagged to prevent freezing. The riser from tunnel to surge tank

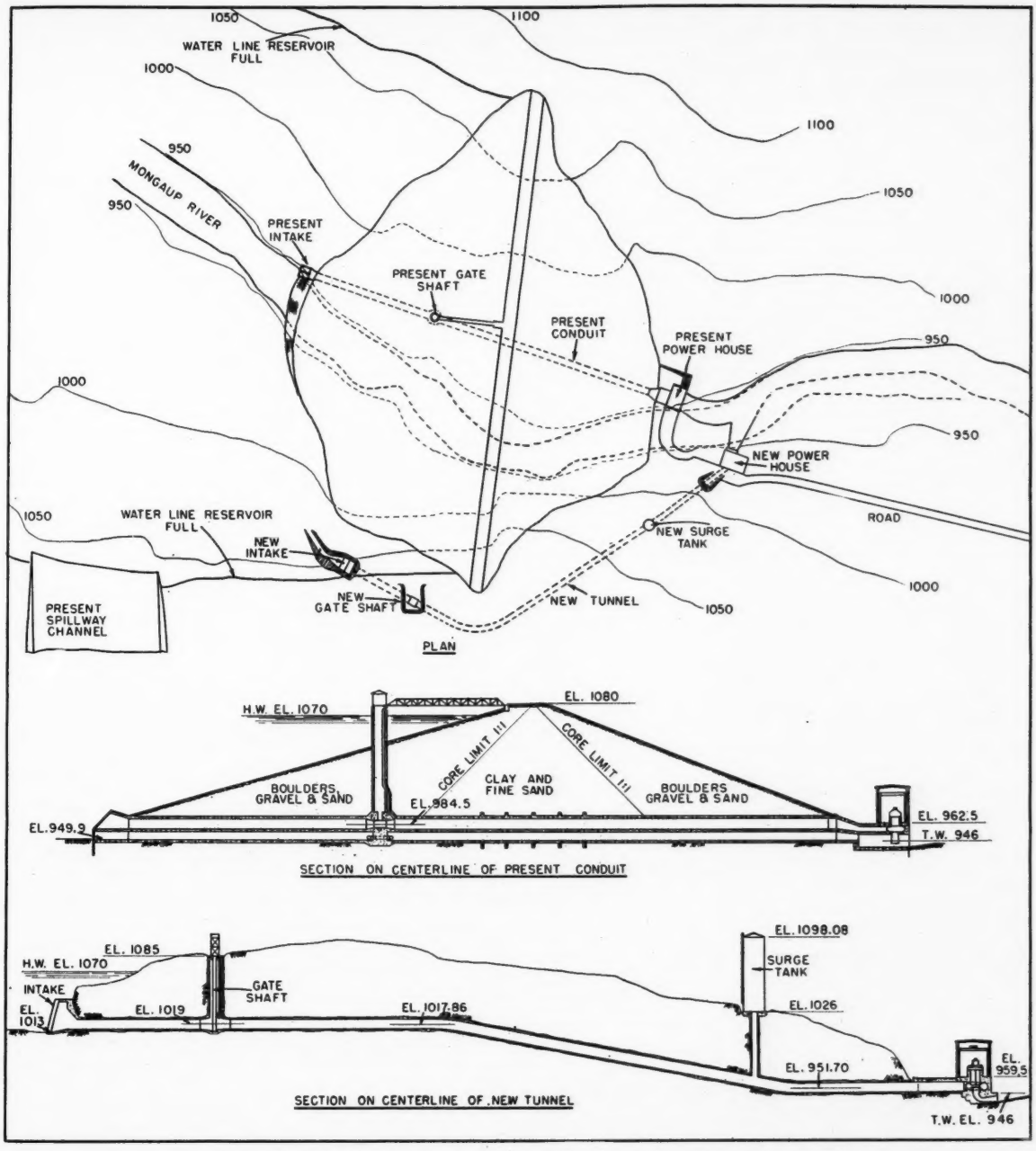


Fig. 4. Plan of the Swinging Bridge Development and Elevation of the existing and new conduits

is 6 ft. diameter, 60 ft. high, excavated in the rock and lined with concrete.

At the downstream portal of the tunnel, provision is made for measuring the flow through the turbine by pitometers. Gate valves 1¼ in. diameter are installed at the top quarter points of the penstock, through which rodmeters with special connections may be inserted and pitometer measurements made. The pitometer rods were rated during recent efficiency tests made on the turbine.

Driving of both the Swinging Bridge and Cliff Lake tunnels was started from both ends at the same time. Due to the water level of Swinging Bridge Reservoir when tunneling was started, shafts were excavated in the rocks near the reservoir end of each tunnel and muck was removed by hoist and bucket. Leakage from the reservoir into the tunnels was small and was largely stopped by grouting.

To hole through at the upstream end of Swinging Bridge tunnel, and to construct the intake, it was necessary to lower the reservoir for a short time. The rock in the tunnels was sandstone and shale, all in massive layers, with horizontal stratification. No timbering was required at any point.

Because of the proximity of Swinging Bridge tunnel to the dam, a hydraulic fill embankment placed about ten years ago, every precaution was taken to reduce vibrations from blasting to a minimum. Depth

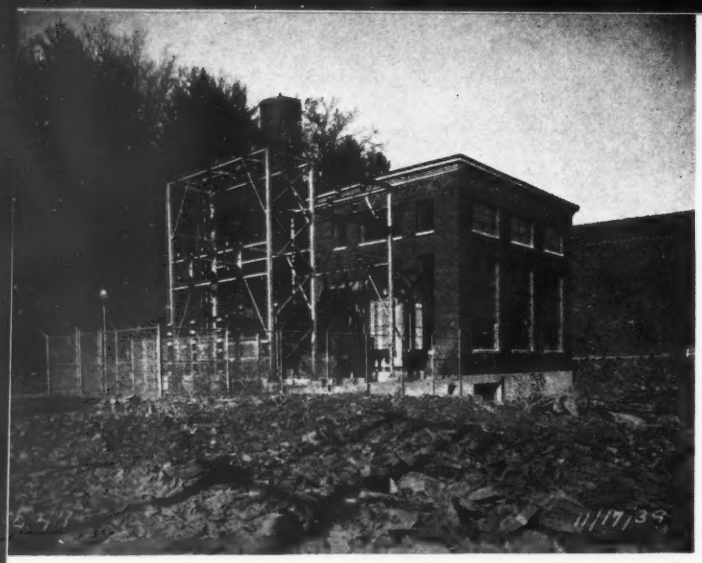


Fig. 5. Swinging Bridge No. 2 Power House. The Dam in right background was built in 1930. Surge tank in center background

of drill holes and consequent loading with explosives was strictly limited. An unusual number of delays between the several rings of holes was required in shooting each face. Special provisions to detect vibration were made in the original conduit and gate tower of the dam, and careful observations were made. No harmful vibrations from the blasting or noticeable effect on the dam were observed at any time during the tunneling work.

Cliff Lake Dam

The original dam forming Cliff Lake was about 25 ft. high and 100 ft. long. It was constructed of dry stone masonry with an impervious earth blanket on the upstream side. This dam forms the toe of the raised earth embankment, the blanket being removed to permit drainage.

Now the dam consists of a rolled fill embankment about 55 ft. high and 260 ft. long, a concrete spillway about 35 ft. maximum height and 100 ft. long, a concrete abutment section 35 ft. high and 150 ft. long which runs into an earth embankment at the east end, forming a core wall for this embankment for a short distance. The spillway is located on sandstone ledge on the east side of the river. West of the spillway the ledge dips down sharply toward the old preglacial valley, as is characteristic of the other dam sites on the Mongaup River, making an earth embankment necessary. Ledge also dips down slightly toward the east.

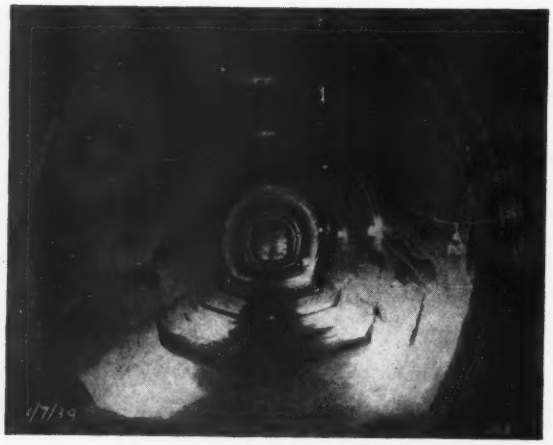


Fig. 6. The Swinging Bridge Tunnel, looking upstream towards closed boomgate

A sluice gate 4 ft. square, with hand operated hoist, is provided in the spillway to let water down to the plants below if desired.

During the construction of the embankment, the stream flow was diverted by a cofferdam into a channel excavated in the ledge on the east side of the river. The spillway sluice gate was located to discharge into this channel, so the channel was lined with concrete to protect the rock from erosion. Earth for the embankment was largely obtained from the excavation of Lebanon Lake channel.

All concrete for the dam was mixed on the west side of the river, and was pumped by a "Pumpcrete" plant through pipes to the various parts of the dam, to a maximum distance of 500 ft. from the mixing plant. A "Pumpcrete" plant was also used for lining Swinging Bridge tunnel.

Cliff Lake and Swinging Bridge reservoir are separated by a ridge of massive sandstone rising over 100 feet above reservoir level. Cliff Lake tunnel was driven through this ridge at its narrowest point, about a mile above Cliff Lake dam.

This tunnel is of horseshoe section, about 6 ft. wide by 7 ft. high, 2,100 ft. long between portals. The rock was hard gray sandstone and no concrete lining was required.

A 5 ft. square sluice gate is installed about 100 ft. from the east end of the tunnel, in the shaft used to start tunnel excavation. Coarse racks are provided at each portal to keep out trash.

Lebanon Lake channel, which conducts water from Lebanon Lake to Cliff Lake, is about 4,600 ft. long, and the maximum cut about 30 ft. Discharge is controlled at the Cliff Lake end of the channel by a 36-inch diameter sluice gate. The normal water depth in the channel is 6 ft., and the bottom width 8 ft.

Lebanon Lake is 65 ft. higher than Cliff Lake, and the discharge through the gate was allowed to make its own channel down into Cliff Lake. Construction on this project started in August, 1938. Tunnel work was carried on in three shifts, working from both ends of each tunnel at the same time. The downstream portion of Swinging Bridge tunnel was holed through early in October. After the Broome gate was put in place as protection against sudden reservoir rise, the upper end of the tunnel was holed through, and the concrete lining and intake completed. Lining of the tunnel downstream from the Broome gate then proceeded. Cliff Lake tunnel was holed through late in December.

Cliff Lake dam was completed in the same year, and water was diverted into Swinging Bridge reservoir early in 1939. The excavation of Lebanon Lake channel was completed in the summer of 1939.

Power house construction started in the fall of 1938 after the tunnel excavation was completed, so as not to interfere with the mucking operations. The river channel below the plants was deepened and widened for about a quarter of a mile to form a suitable tailrace for the combined discharge of the two plants. The plant was finally put in operation October 1, 1939.

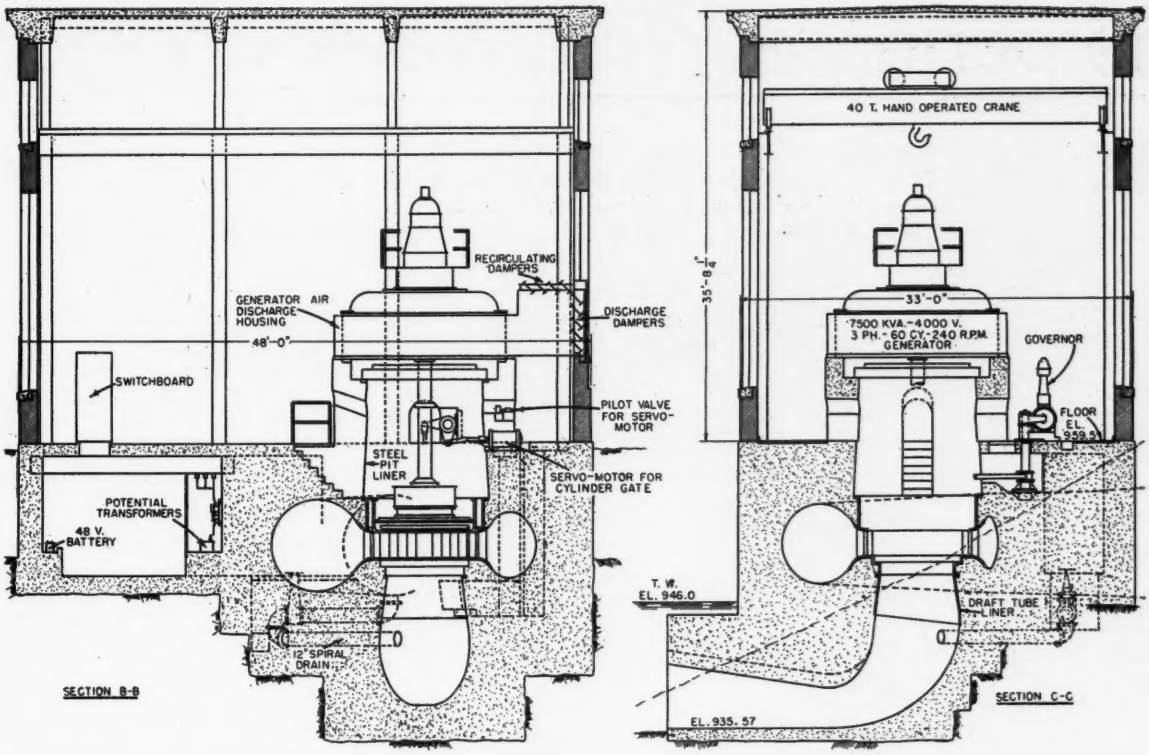


Fig. 7 and 8. Generator and Basement Floor Plan of No. 2 Power House

Manufacturers of equipment for this development are given below:

Turbine—S. Morgan Smith Company.

Generator—Westinghouse Electric & Mfg. Co.

Switchboard and Switchgear—General Electric Co.

Transformer—Allis-Chalmers Mfg. Co.

Power House Crane—Whiting Corp.

Steel Penstock and Surge Tank—Bethlehem Steel Co.

Broome Gate—Philips & Davies, Inc.

Filler Gate Valve for Broome Gate—The Ludlow Valve Mfg. Co.

Sluice Gates—Chapman Valve Mfg. Co.

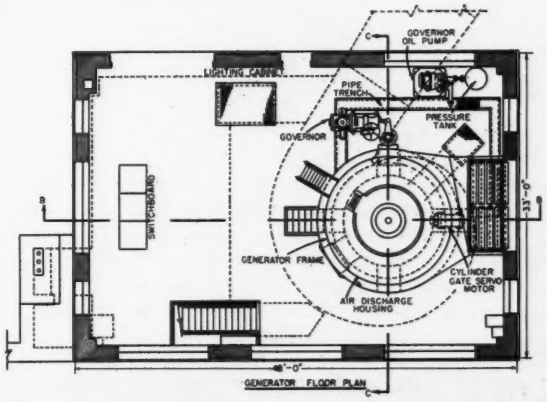
The general contractor for Swinging Bridge tunnel, Cliff Lake dam, Cliff Lake tunnel, Lebanon Lake channel, and the power house substructure, including erection of the Broome gate, penstock, and surge tank, was Ephraim E. Sanders, Inc., of Portland, Maine.

The general contractor for the power house superstructure was Harold H. Smith, Inc., of Middletown, N. Y.

Electric wiring was done by the Company's forces.

Cliff Lake reservoir was cleared by Dean Brothers of Cahoonzie, N. Y.

The plans and specifications for these developments were prepared by Chas. T. Main, Inc., Engineers, of Boston, Mass., under the supervision of W. F. Uhl, and in cooperation with the operating forces of the Rockland Light and Power Company, and with Mr. F. L. Lovett, Vice-President and General Manager. Mr. E. M. Wilbur was resident engineer representing both the engineer and the company.



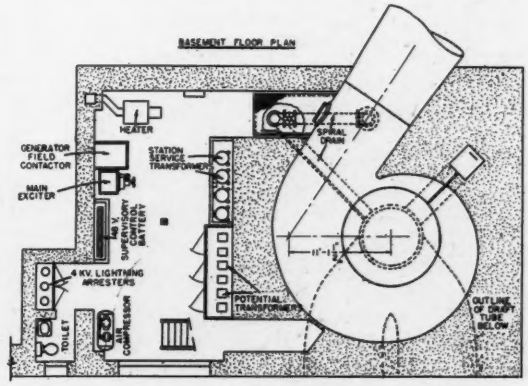


Fig. 9 and 10. Sectional elevations of No. 2 Power House

Experience With Water-Cooled

Two water-cooled stokers installed January and July, 1938, respectively show a combined maintenance cost of less than 0.8 cent per ton of coal fired over a 19-month operating period.

By V. L. JONES
The Utility Management Corporation
Reading, Pa.

DURING the latter part of 1936, the decision was made to increase the capacity of the Seward Station of the Pennsylvania Electric Company. Plans at that time contemplated the addition of a 35,000 kw. turbo-generator, and two steam generating units, each with a maximum capacity of 200,000 lb. per hr. along with the usual attendant auxiliary equipment. The installation of the steam generating units was carried through to completion, but the turbine installation was deferred.

Each steam generating unit comprises a Babcock & Wilcox Stirling type boiler with water walls, an integral economizer and a superheater, designed for operation at 675 psi, 825 deg. F. final total temperature, fired by a Taylor water-cooled underfeed stoker, as manufactured by the American Engineering Company. The general arrangement of each unit is as shown in Fig. 2, under the caption "Boiler No. 8," which is the plant number of the unit first installed, Boiler No. 2 being a duplicate in all respects.

Steam generated by these two units is passed through a reducing valve and desuperheater station to the old header which is operated at 285 psi and 600 deg. F. maximum. The low pressure header supplies two 24,000 kw. turbo-generators, one of which has a surface condenser and the other a jet condenser. The steam output of the new boiler equipment is governed by the amount of condensate available from the surface condenser for feedwater. For this reason the new units, when in parallel, are operated below the ratings originally contemplated. However, each unit has been operated at full load although not for extended periods.

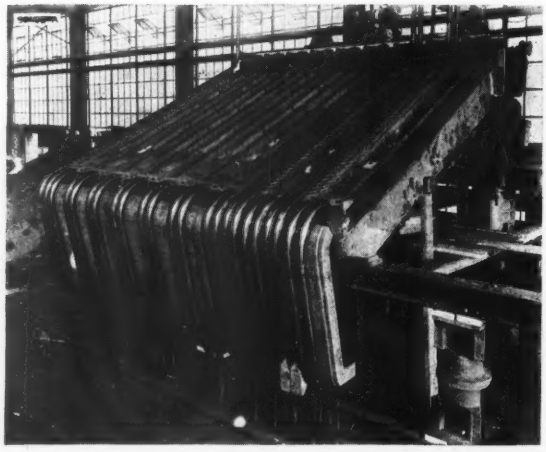


Fig. 1. Details of stoker assembly as set up in the factory

The firing equipment for each unit consists of a Taylor 13-retort, water-cooled stoker, of 429 sq. ft. projected area, 22 ft., 8 in. inside width between side walls by 18 ft., 10¾ in. in depth.

The stokers are normally driven by Terry turbines through conventional reduction gearing under Bailey combustion control and 15 hp., 4 speed a.c. motors serve as auxiliary drives. The double 18 in. crusher rolls are actuated by means of hydraulic cylinders to which oil is supplied by motor driven Hele-Shaw pumps. The stokers were designed to burn 21,000 lb. of coal per hr. each, at maximum rating when operating in the low speed gear boxes.

The station was originally built as a mine mouth plant. Coal supply is obtained from the adjacent company-owned mine in Indiana County, with analysis characteristics as follows:

TABLE I

Moisture	2.95%
Volatile	19.83
Fixed Carbon	65.24
Ash	11.98
B.t.u.	13,500
Sulphur	3.5
Fusing Temp. Ash	2250°F

The fuel is passed through a crusher and contains a relatively large amount of fines and slack as it reaches the stoker hoppers, there being two down spouts with conical spreaders for each stoker. General details of the stoker assembly are shown in Fig. 3 which, for the sake of clarity, omits some structural items. Details of the stoker assembly are as shown in Fig. 1, which portray an exactly similar unit during factory assembly. The arrangement of water cooling tubes, tuyeres, pusher rods, and extension grates, is identical with the typical sections given in these latter figures.

The first unit to go in service was No. 8 during January 1938, followed by No. 2 in the latter part of July of the same year. A check-up of service data and maintenance expense was made to include the last 7 months of 1938 and all 12 months of 1939.

Stokers At Seward Station

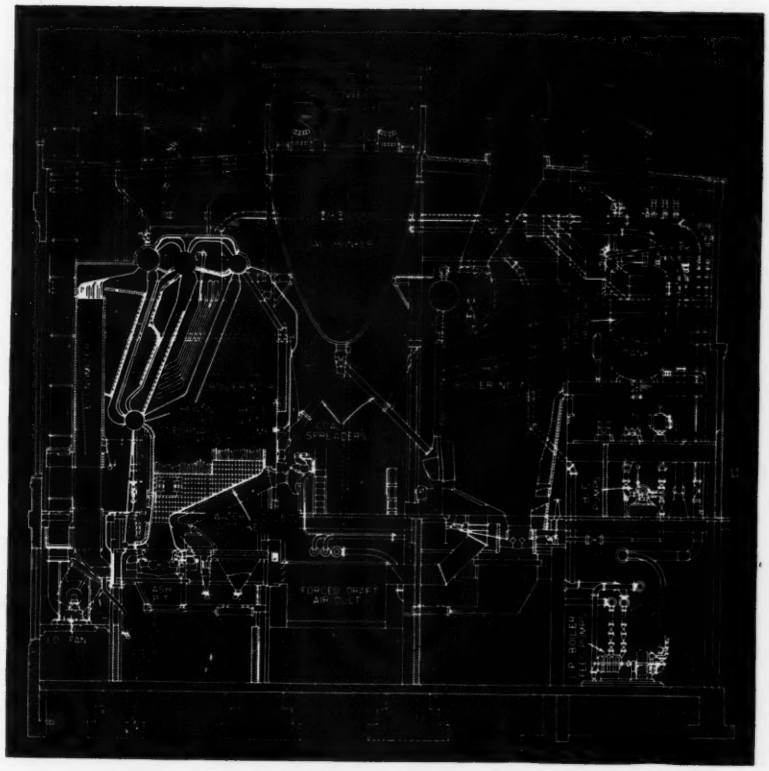


Fig. 2. Elevation, showing the general arrangement of equipment in the boiler room of Seward Station

This omits experimental time during the first part of 1938 on one unit, during which attention was necessary to some portions of the steam generating unit, other than the stoker, and constituted a shakedown period.

Operating performance for the two units for the period in question is shown in Table II.

The capacity factor remains below 80 per cent due to the load limitation imposed by the desire to use only condensate for feedwater, but a higher factor is expected when the new turbine unit is installed and makes possible higher base load operation. The difference between the high availability factor and the use factor is a result of outage caused by other portions of the steam generating unit, and by scheduled attention to main turbines during annual periods of inspection and over-haul. Capacity, unit operation and availability factors are all calculated in accordance with standard E.E.I. practice. There is virtually no banking time for either unit, the total being 5 hr. for No. 2, and 13 hr. for No. 8, for the period covered in Table II, since these units are operated essentially on base load.

Maintenance charges for the period under discussion are shown in Table III. It is expected that the first unit in service would show somewhat more maintenance, but this has been confined to relatively small items, mostly in the ash-pit area. As originally installed, cast iron aprons were provided to protect the lower water tube headers, but it was found necessary to apply similar aprons at the rear of the ash pit in order to prevent excessive depreciation of the crusher roll supports. The coal being high in sulphur content caused a more rapid corrosion of material than was originally expected. This accounts to a large extent for the increase in maintenance on No. 8 as compared to No. 2. Furnace maintenance is also listed in Table III and is notable for its low value.

Careful observation has been made of the tuyere and water cooling assembly from time to time. For the first two years of operation, all original tuyeres were in completely satisfactory condition, but it is expected that replacement of some tuyere support castings will become necessary during the early part of 1940. Despite fuel characteristics of high sulphur content and low fusion ash, there has been no apparent erosion or corrosion of the cooling tubes to date, these having been carefully measured periodically.

There has been a failure of one water cooling tube in one unit only. This tube was found to be defective and was replaced by the manufacturer free of charge, although outage time and station maintenance have been included for this item.

Crusher rolls have been generally satisfactory, the only essential change required being the replacement of teeth with others of a modified contour in order to eliminate breakage. This breakage, while readily apparent, did not reduce the effectiveness of the grinding equipment to a point sufficient to affect capacity. The modified tooth design was adopted in order to reduce this item of maintenance expense. While most of the operation has been at the capacity factor noted, there have been a sufficient number of times when each unit has been to full load and down to partial loads, to insure satisfactory operation over a range of from 20 to 100 per cent of rated capacity. Response to load changes is rapid and accurate with full flexibility throughout the load range indicated.

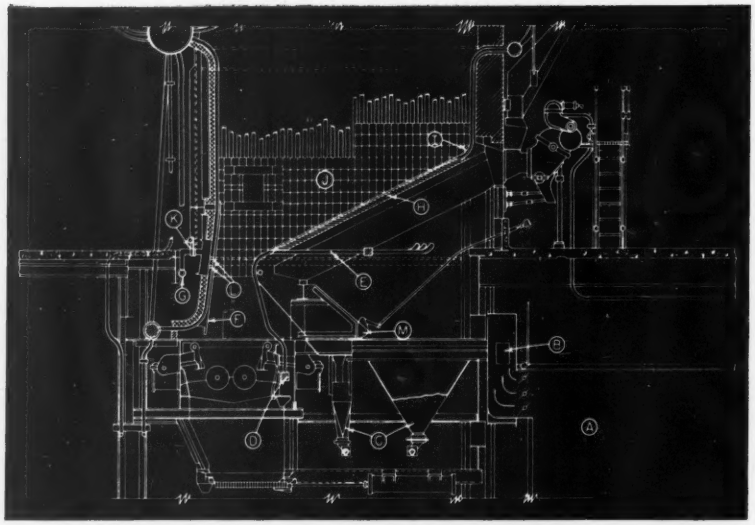


Fig. 3. General details of the water-cooled stoker installed on boilers Nos. 2 and 8

LEGEND

A—FORCED DRAFT AIR DUCT
B—ASH PIT AIR SUPPLY TAKE-OFF
C—SIFTINGS HOPPER
D—STOKER WATER TUBE SUPPLY HEADER
E—RAM WATER TUBES
F—BARE BAILEY BLOCKS
G—ASH PIT AIR SUPPLY DUCT
H—STOKER TUYERES
I—TUYERE WATER TUBES
J—BARE BAILEY BLOCKS
K—ASH PIT AIR CONTROL VALVE
L—ASH PIT AIR SUPPLY
M—AIR TO EXTENSION GRATES

Zoning is confined to four compartments across the width of the stoker, and from all indications, this is ample to control fuel bed conditions. Original settings established on the push rods for stroke control have been essentially maintained for a considerable time, and require but a small amount of adjustment, though at times, due to the bunker and down spout arrangement, half of the stoker may have mostly lump coal, and the other all slack.

TABLE II

	No. 2 Unit	No. 8 Unit	Combined
Total Coal Fired—Tons.....	85,840	87,477	173,317
Period Hours in Service	10,552	10,876	21,415
Demand Hours for Service...	10,712	11,147	21,859
Total Period Hours	12,432	12,432	24,864
Average Hourly Firing Rate —lbs.	16,260	16,120	16,190
Average Capacity Factor —per cent	77.0	76.7	76.9
Unit Operation (Use) Factor —per cent	84.7	87.6	86.1
Availability Factor—per cent	98.3	97.5	97.8

TABLE III

	No. 2 Unit	No. 8 Unit	Combined
Total Coal Fired—Tons.....	85,840	87,477	173,317
Stoker Maintenance			
—Labor	170.63	763.89	934.52
—Material	19.24	268.25	287.49
—Total	189.87	1,032.14	1,222.01
Stoker Maintenance Cost per ton of coal fired—cents...	0.221	1.178	0.704
Furnace Maintenance			
—Labor	58.39	38.86	97.25
—Material	45.18	72.07	117.25
—Total	103.57	110.93	214.50
Furnace Maintenance Cost per ton of coal fired—cents...	0.121	0.126	0.124
Total Stoker and Furnace Maintenance	293.44	1,143.07	1,436.51
Total Maintenance Cost per ton of coal fired—cents....	0.342	1.309	0.828

As originally installed, admission of air to the ash pit section through the rear wall was too generous, and much of it at too high an elevation. This was corrected by permanently sealing the unnecessary upper slots and was accomplished without changing any block armor on the rear wall tubes.

There is no provision for adjustment of ram box liners to compensate for wear and accordingly this has been a matter of particular observation. To date, what little wear has occurred is quite small, as judged by the amount of siftings deposited on the operating floor, and can be disregarded. The siftings deposited by the under-feed and extension grate sections do not appear to be excessive, especially in view of the fuel characteristics.

On other units in the station the low grade fuel characteristics naturally are reflected in high furnace maintenance, development of large clinker, and the tendency for fuel bed conditions to become quite irregular. The same fuel handled on the water cooled stokers is noticeablly free from the development of such conditions, and is likewise reflected in low stoker and furnace maintenance along with appreciably less ash pit losses. The improvement at the back end of these new stokers is quite noticeable.

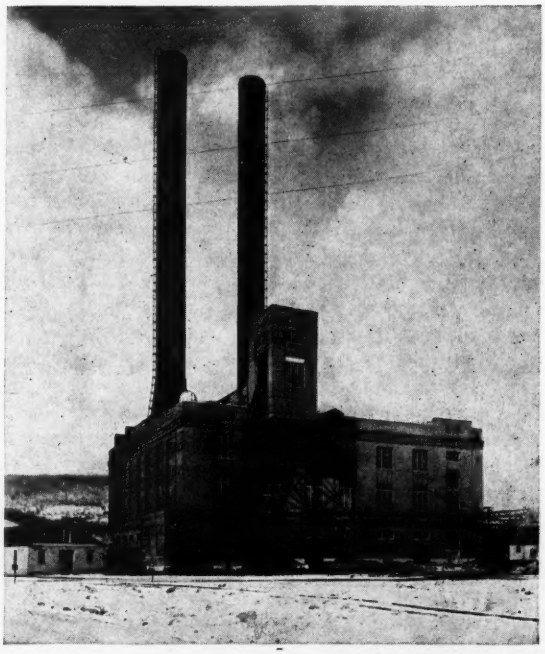


Fig. 4. View of Seward station

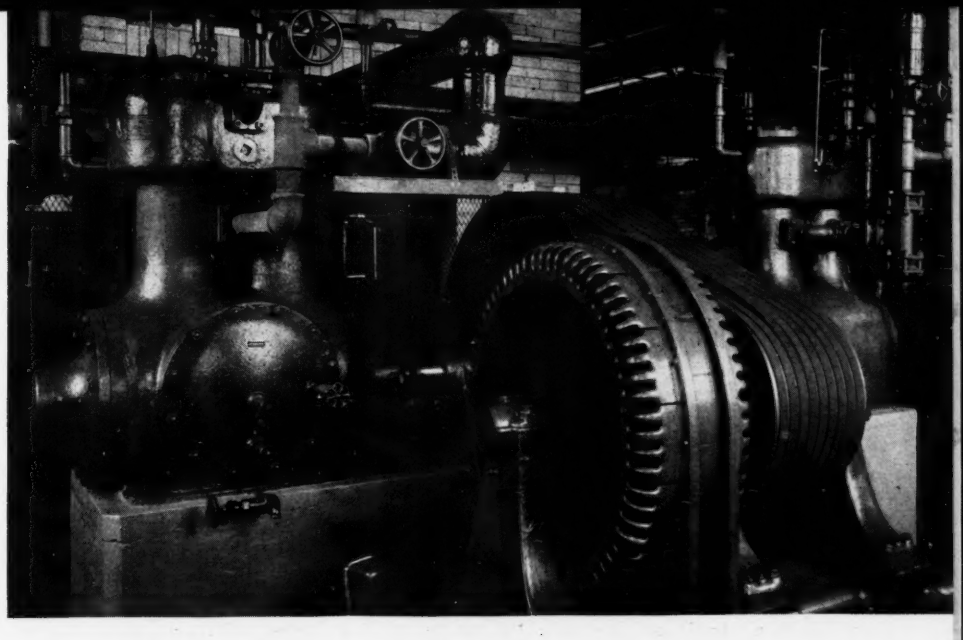


Fig. 1. The compressor is the heart of the refrigerating system.

REFRIGERATING PLANT MAINTENANCE

By BERNARD T. HENSGEN
Plant Engineer, Swift & Co.
National Stock Yards, Ill.

AFTER PRESCRIBING REMEDIES for many of our common problems, a currently popular song concludes: "Comes Love: Nothing can be done!" This yielding of the human heart to the darts of Cupid is a fine and beautiful experience—one hardly to be considered with the question of maintaining a refrigerating plant. But the lyric may be parodied to put the words in the mouth of the refrigeration engineer: "Comes Summer: Something must be done!" Something must be done to constantly dispose of the millions of B.t.u's convected, conducted, and radiated into those places where modern industry desires that there be very few of these troublesome heat units. The heart may capitulate, but the refrigerating system may ask for no quarter during these months.

WHAT ABOUT YOUR PLANT?

DO you operate a refrigerating plant? If so, what are you doing to maintain its operating efficiency? Just because the equipment keeps moving is no indication that it is operating efficiently. The compressor cylinder may be worn, the valve seats may be in poor shape, scale may have accumulated in the condensers. These things cannot be seen nor are they easily evident. ¶ In this article Mr. Hensgen discusses the various things to look for in the operation of a refrigerating plant and what they mean. Perhaps you know of many or all of these things but even so, it will do no harm to read these suggestions. Mr. Hensgen's practical experience with refrigerating plants provide him with an excellent background against which to present this subject for the benefit of this practical operating engineer.

The question of refrigerating plant maintenance can best be approached by discarding all notions of similarity between maintenance and repairs. It is often thought that the maintenance man is "the fellow in the blue overalls who fixes things when they bust." That fellow is actually the "repair man." The maintenance man, if he is on his toes, is the man "who keeps things from getting busted." He practices preventive maintenance and by so doing greatly reduces and sometimes eliminates costly repairs. Maintenance is a function of operation. In fact, it is the prime consideration of good operation.

At this time of the year particularly, good operation and good maintenance go hand-in-hand. Now the peak of refrigeration loads occur, and demands are made on the refrigeration plant that often exceed its reasonable capacity. To maintain smooth operation at all times and to safely pick up peak demands, the operating engineer should have a definite operating policy established according to

local plant conditions. All operating engineers know their individual machines better than anyone else. To prescribe a certain routine for machine attention would be as welcomed by them as a driver in the rear seat of their automobile. However, a few facts and figures applicable to refrigerating plants in general, and to ammonia systems specifically, might well be in order.

The Compressor

The compressor is the heart of the refrigerating system. The effectiveness of maintenance and operation is reflected in the amount of work the compressor is required to perform. If the cylinders are allowed to become excessively worn and out of round, the operation is bound to be inefficient; if the valve seats are in poor shape, inefficiencies will result; faulty rings are similar in effect to misshapen cylinders. Rod packing may be too loose and cause loss of cylinder capacity, or it may be too tight and score the rod. In all of the above cases, the compressor will be required to perform more work per ton of refrigeration than good operation warrants.

It is good practice to check all moving parts, friction surfaces, cylinders, etc., of the compressor each winter when the load slacks off. Records of these annual winter over-hauls soon form important indicators as to the expected performance of compressors during the peak season. Also, time is afforded to recondition and shape-up worn parts in a careful and leisurely manner while the system is "coasting downhill" with light loads. Winter overhauling should become a regular routine with good operation much the same as the old story about the backwoods lad who received his annual scrubbing every year on his birthday "whether he needed it or not."

While winter is the natural check-up and fix-up period, summer is the time of greatest wear and tear. On the suction side of the compressor piston is maintained the lowest pressure in the entire system, and on the discharge side is maintained the highest pressure. This pressure variance is the motivating force which causes the refrigerant to flow through the system. In maintaining this pressure differential the compressor "does the work" of refrigerating and the less work it is required to do the longer will be its useful life, and the less frequently will it require major repairs. Thus, good compressor maintenance goes somewhat beyond the machine itself.

Since the work of the compressor is proportional to the difference in suction pressure and head pressure, proper adjustment of these factors will improve the operation of the machine. A decrease of 2 lb. in discharge pressure reduces the horsepower requirements one per cent, while an increase in suction pressure of 1 pound reduces the horsepower requirements by two per cent. Thus, if the discharge pressure is 10 lb. higher than necessary, and suction pressure is 5 lb. lower than required, the compressor is doing fifteen per cent excess work. Suction pressure has a pertinent bearing on compressor capacity also. For example: When operating at about 180 lb. condensor pressure, an increase in suction pressure from zero to 5 lb. decreases required cylinder capacity 20 per cent. This capacity increase is occasioned by the great volumetric expansion of ammonia gas at the lower pressures, and this percentage will decrease as the suction differential is taken in the higher ranges. Condensor pressures do not have so marked an effect on capacity. A decrease from 200 lb. to 160 lb. while expanding at 10 lb. will reduce required cylinder capacity about 4 per cent. Since cylinder capacity means piston travel, r.p.m's, etc., any reduction in required capacity will be reflected in less wear and tear on many moving parts.

Quality of Suction Gas

Another consideration which affects the compressor is the quality of the suction gas. Every engineer knows what can happen if a sudden surge of liquid ammonia enters the compression cylinder. The maintenance phase is abruptly terminated and repair of the wreckage is begun. While the immediate result of "sloppy" suction gas containing entrained liquor is not so violent, operating inefficiencies are occasioned by compressing ammonia which evaporates in the cylinder and does no useful refrigeration. It is therefore a principle of good maintenance to insure a supply of dry gas to the compressor. About 5 to 10 deg. of superheat will accomplish this. However, it is well to remember that too much superheat is to be avoided. Excessive superheat requires an increase in horsepower and decreases cylinder capacity. Good gas conditions may be maintained by having thermometers in the suction and discharge lines. To quickly check the suction gas quality subtract ten from the pressure shown on the suction gage. The result should be the approximate gas temperature. A lower temperature indicates a tendency toward a saturated gas condition while a higher temperature indicates too much superheat. The above rule allows about a 5 deg. margin to the saturation line. If a 10 deg. margin is desired, subtract 5 deg. from the indicated pressure when approximating the temperature.

The discharge line thermometer should indicate within ten per cent the temperature obtained from a simple slide rule which any engineer may construct to fit his particular conditions. The accompanying sketch illustrates a rule for condensor pressures from 140 lb. to 180 lb. and suction pressures from 0 lb. to 30 lb. The proper discharge temperature will be indicated at the intersection of the proper condensor pressure line with the slide cross-hair placed on the proper suction pressure.

After leaving the compressor the hot gas goes to the condensor where it passes through the latent heat stage, goes back to the liquid state and is ready to pass through the system once more. The condensor, usually through the medium of the condensor water, dissipates the removed heat into the atmosphere. About 255 B.t.u. are removed at the condensor for each 200 B.t.u. absorbed in the expansion coils and the effectiveness of this heat removal has an important bearing on plant operation. If

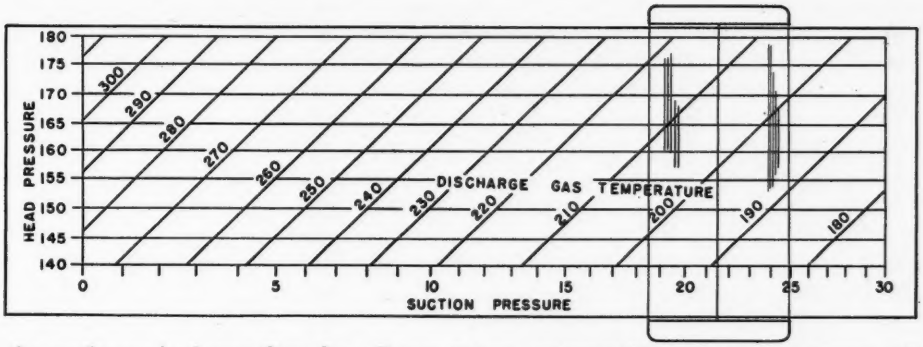


Fig. 2. Discharge-gas temperature slide rule (all pressures are given in pounds per square inch gage)

the heat removal at the condensor is slower than the heat absorption at the evaporator, condenser pressures will rise. It was previously pointed out that for each 2 lb. reduction in head pressure a saving of one per cent in power input is realized.

Condensers

Three types of condensers are most commonly used: atmospheric pipe, shell and tube, and double pipe condensers. Perhaps the atmospheric condenser is the most common although it is rapidly giving way to the shell and tube type. Regardless of the type in use, condenser operation should not be taken for granted. The many joints are potential ammonia leaks, and the hot surfaces frequently build up insulating deposits of scale. In the atmospheric type condenser ammonia leaks are detected by visual inspection. They appear as gray calcium salts at the point of the leaks. Scale accumulation can be kept at a minimum by frequent washdowns with water under high pressure such as that from a fire hose. Leak detection and washdown of the open shell and tube condenser is similar to that of the atmospheric type.

The double pipe and multipass shell and tube condensers, however, have the ammonia piping concealed. Leaks in condensers of this type are not visible and regular testing of the effluent water with red litmus paper or Nessler's solution must be followed. Cleaning does not present a very serious problem if close attention is given operating conditions. Compressed air introduced with the cooling water is effective in removing loose sediment and soft scale. Chemical cleaning may be used, but this is advisable only when performed under the supervision of a competent chemist.

Cooling Water System

All types of condensers should be inspected, thoroughly cleaned, and overhauled annually. Parts subject to rusting or corrosion should be conscientiously checked and tested and if found wanting should be immediately replaced. Oil traps in hot gas lines are not 100 per cent efficient and condensers should be regularly checked for oil accumulation.

Condenser maintenance is not complete unless attention is given the cooling water pump. An appreciable percentage of total power required is consumed in supplying water to the condensers. Performance of centrifugal pumps and rotary pumps can be checked by regularly following power requirements and comparing them with original data. Steam driven reciprocating and turbine pumps will usually plug along even if defects approach major proportions. Day to day observation of both these types, however, usually furnishes ample warning of impending failures. Pumps should be inspected semi-annually if easily accessible, and cleaned or overhauled annually, depending on water conditions.

A careful consideration of water and pumping costs weighed against power costs will determine the most economic condenser pressure for any particular installation. Once determined, it should be maintained by careful attention to condenser and pump operation.

Maintenance of the refrigeration piping system is probably the greatest single item of the entire plant maintenance. This is due partially to the amount of piping involved and partially to its being located in out of the way places or passing through any number of varying conditions. Pitting and corrosion are major factors to be coped with. Since corrosion eats away pipe metal, it usually shows up mostly at threaded joints. Careful inspection of threaded joints at regular periods will enable the maintenance man to adopt a schedule of cleaning and painting through which he can effectively combat this evil. Of course, certain locations will require more attention than others, and this should be considered in the schedule. The use of welded lines greatly reduces this local corrosion problem, but care must be exercised in welding ammonia lines. Because of the annoyance caused by scale and metal particles in refrigeration piping, it is essential that welded joints provide a tight metal to metal contact. If simple precautions are observed and an experienced welder is employed, welded jobs prove very satisfactory. Welds must be protected with a good paint or they will form a spot especially susceptible to corrosion.

Local corrosion should be guarded against at all pipe hangers and supports. An electrolytic action sets up between the two metals and accelerates the deterioration. Also, any vibration aggravates the condition by abrasion. Rigid pipe hangers should be provided, and these should receive special attention and protection in the maintenance program.

Expansion Coils

Expansion coils generally present the same problems as the rest of the piping systems. Here, however, an additional source of deterioration is pre-

(Continued on Page 55)

HIGH

Fig. 1. Armature of a direct current generator with vee ring commutator

COMMUTATORS for direct current generators and motors and for commutating alternating current motors are universally built of copper segments with mica spacers or strips between the bars for insulating them electrically, one from the other. The armature coils are, of course, attached to the individual commutator bars; and bushings usually of carbon or carbon graphite are used to ride upon the commutator surface for collecting the current.

Copper, in the hard drawn form, is used for the commutator bars because it can be easily drawn and machined to shape, is a good electrical and heat conductor, is relatively strong mechanically, will maintain a good surface polish or glaze, will not blister except under severe arcing or flashover, and permits good contact being made between the armature coils and itself by simply soldering.

Mica is used between the bars for insulating them from each other and between the assembled bars and the steel parts supporting them, because it is a very good electrical insulator and because it has the mechanical properties necessary in an insulator for such service. These properties are good mechanical strength in compression and the ability to season or go through a temperature cycle of contraction and expansion. Mica, for commutator construction, is built up of thin flakes of white mica bonded together with special shellacs or other special binders. The characteristics and amount of bond in built up mica is of prime importance in the ability of the mica to season. The bond material also acts as a means for holding the bars together since it causes the mica strip to adhere to the bars.

High speed commutators are generally of two types; (a) the vee ring type of commutator, and (b) the shrink ring type; the names distinguishing the type of mechanical construction used for holding the bars in place.

Vee Ring Commutators

Figure 2 is a sketch of the latest type of vee ring commutator as used on medium high speed motors and generators developed for industrial applications. The bars are made from drawn sections tapered in a radial dimension so that with constant thickness strips of mica a tightly built up assembly of copper bars and mica will be secured. With the bars evenly assembled and held in clamp rings, a vee is machined in each end of the bars. Into the vee's are fitted formed mica vees, made of built-up mica, usually in a two layer thickness of half overlapped segmental sections. Two steel vee rings machined to fit the mica vees, fit in these vees machined in the ends of the bars, thus holding the assembled copper bars and mica segments together.

The vee rings themselves are a part of or are supported from the commutator bushing, which in turn is mounted on the shaft of the machine. Bolts or studs are used for holding the vee rings together in axial relation to each other.

Vee ring commutators are of three types in regard to the vee construction; (a) drum bound, (b) arch bound and (c) vee bound. The difference in construction depends entirely upon where the pressures are exerted in the vees.

If the vees in the copper and the steel vee rings are machined to such diameters that the vee rings in being drawn towards each other exert practically all their force on the 30 deg. vee and if the thickness of the copper bars and mica is such that there is little pressure circumferentially between the bars, and if the inside of the assembled commutator bars is machined as the inside of a cylinder, and if the commutator bushing is machined as a cylinder with a thin mica cylinder around it; then the commutator bars will be drawn down against the mica bushing cylinder and the commutator will be "bushing bound." Obviously, the dimensions and machining of the parts will have to be done so that there will be a considerable pressure of the inner diameter of the bars against the mica bushing, a slight pressure in a circumferential direction between the bars and bar mica and also slight pressure between the mica vee ring and the bars on the 3 deg. vee. Of course, there will be an extremely heavy pressure between the mica vee rings and the bars on the 30 deg. vee. In this type of construction, the bolts holding the two vee rings together must pass through holes drilled through the commutator bush parallel to the shaft. The disadvantage of this type of commutator is that there is very poor provision for expansion due to temperature, since the bars are bound down tightly against the mica bushing.

With the commutator bushing made smaller in diameter so that there will be no pressure exerted between the inner diameter of the commutator copper and the steel and with most of the vee ring pres-

SPEED COMMUTATORS

By C. LYNN
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sure exerted on the 30 deg. vee, the bars will be forced inwardly in a radial direction forming a circular arch with the bars with a circumferential arching pressure between the bars. A commutator so made is known as an "arch bound" commutator. The disadvantage of such a construction is that it distorts when the commutator gets hot and expands. When expansion occurs, it will become egg shaped and some of the bars will become higher than adjacent ones and poor commutation will result.

The "vee bound" construction holds the bars in place by the wedging action of the vee rings in being clamped together by the vee ring bolts. With such a construction it is theoretically possible for the individual bars to be held in space position with the mica between bars removed but, of course, such a construction is a practical impossibility as the bars would shift and buckle. In making such a design the dimensions of the vees in the copper and the vee rings are made such that pressure is exerted on both the 30 deg. and 3 deg. vees and the pressure exerted on the 30 deg. vee forces the bars in radially, so as to exert some circumferential or arching pressure, but less than in an arch-bound commutator. This vee bound commutator construction has been found to give the best operating results because the effects of centrifugal force and expansions due to temperatures of operation cause less distortion and buckling of the commutator surface than either the drum bound or arch bound construction. This is the type of vee ring commutator that is built at the present time. Figure 1 shows such a commutator assembled on a complete armature.

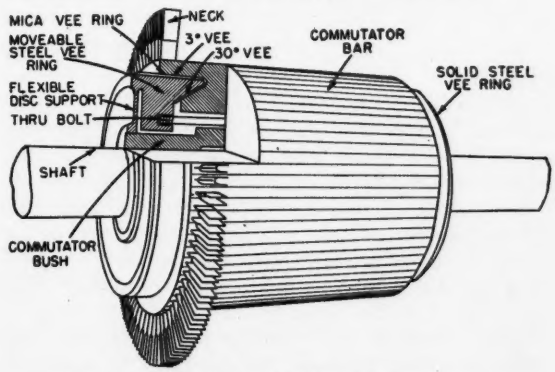


Fig. 2. Medium size, modern design commutator.

The gradual yielding and settling of the mica and the copper under stress, temperature and time until a final stable condition is reached is referred to as seasoning. This is accomplished by repeated cycles of heating and cooling of a commutator during the tightening process and is done both with the commutator stationary and rotating, depending upon the size and type of construction. This process takes from a few hours to several days, depending upon the size and speed of the commutator. This is a very important part of commutator building since a commutator must be able to go through repeated temperature cycles, from room temperature to as much as 100 deg. C. and back again without roughening. Bar movement greater than 0.0001 in. from one bar to the next cannot be tolerated as it will result in sparking. Note, that bar to bar roughness should not be confused with commutator eccentricity. Eccentricity of 0.001 in. is permissible on high speed commutators operating at 5000 to 10,000 ft. per min. peripheral speed, with even greater tolerances at lower speeds.

In addition to correct vee and vee ring machining, it is necessary for the steel structure to be correctly designed and built so that the commutator can go through a temperature cycle without developing excessive pressures or distorting out of proportions.

Many methods of supporting the vee rings have been developed during the past years but the recent design indicated in Fig. 2 has given the best results because it permits expansion without distortion. In this design the front or solid vee ring (not shown in cross section in the drawing) is cast solid with the commutator bushing. The rear or floating vee ring is made heavy in cross section to eliminate twisting and distortion due to the pressure exerted on the vee part of it and the pull of the through bolt. It is supported from the commutator bushing by means of an integral flexible disc supporting ring pressed on the bushing. Through bolts, extending through holes in the front vee ring, are threaded into holes in the rear vee rings. The number of bolts, their size and the material of which they are made, are chosen so that the desired pressure can be exerted between the two vee rings.

In operation, as the bars expand in a direction parallel to the shaft due to temperature of operation

produced by the friction of the bushings riding upon the commutator and the bushing contact electrical loss of the current flowing between the bushings and commutator bars, the rear vee ring is forced a small fraction of an inch further away from the front vee ring. By correct proportioning of design, the through bolts will stretch within their elastic limit, thus holding the assembled mass in correct position without excessive pressures being exerted by the vee rings, upon the vees in the ends of the commutator bars. As the rear vee ring moves slightly in a direction parallel to the shaft, the flexible disc supporting ring is dished or warped a slight amount since it is made of thin section. In so doing, it holds

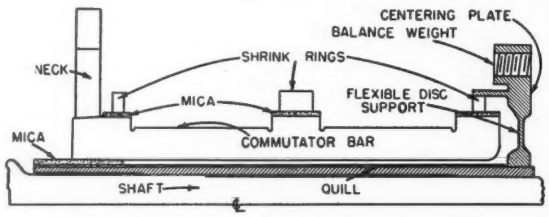


Fig. 3. Modern design shrink ring type commutator.

the rear vee ring perfectly centered in respect to the shaft so that axial movement of commutator is permitted with temperature expansion without incurring eccentricity. Expansion in a circumferential and in a radial direction of the commutator without buckling or excessive distortion is provided by the compressibility of the mica between bars.

Vee ring commutators can be built to relatively large diameters and fairly long face lengths, and with commutator-peripheral speeds up to 6000 or 7500 ft. per min., if the face length of the bars is not too great. Where higher peripheral speeds or longer commutators are necessary, a shrink ring type of commutator has to be employed.

Shrink Ring Commutators

Such a type of commutator is shown in section in Fig. 3. In this construction the bars instead of being held by vee rings at the ends of the bars are held by shrink rings over the outside diameter of the assembled bars. Mica is used for insulation between the rings and the bars and also as strips between the bars themselves as well as between the bars and the quill or commutator bushing.

These commutators must also be put through a seasoning cycle, differing, however, from that of the vee ring commutator which can have its bolts tightened during seasoning.

Many different designs of shrink ring commutators have been made but the recent design as indicated in Fig. 3, known as the floating type and incorporating the same principle of construction for taking care of temperature expansion as is used in the vee ring commutator of Fig. 2, has given superior operating results.

In this case the assembled bars and bar mica are bound down on a short mica ring surrounding the quill or commutator bushing for a short distance at the rear or neck end of the commutator. The rear shrink ring holds the bars tightly down on the mica ring at this point. The other end of the assembled bars is supported by a flexible centering plate, a section of which is shrunk over the outer periphery of the front shrink ring. The centering plate in turn is pressed on the quill. The commutator itself is built on a quill so that it can be manufactured separately from the shaft on which it can be pressed when finished.

Referring to Fig. 3, it can be seen that as the commutator heats up in operation, the bars will expand axially toward the centering plate and it having a thin section will bend or warp, still keeping the front end of the assembly perfectly centered in respect to the shaft. The cylindrical portion of the centering plate projecting towards and over the front shrink ring, being thin in section, permits radial expansion of the commutator, the shrink ring, elongating circumferentially but still keeping that end of the commutator perfectly centered.

Sufficient pressure is exerted by the rear shrink ring to hold the rear of the commutator centered upon the inner mica bushing even with the expan-

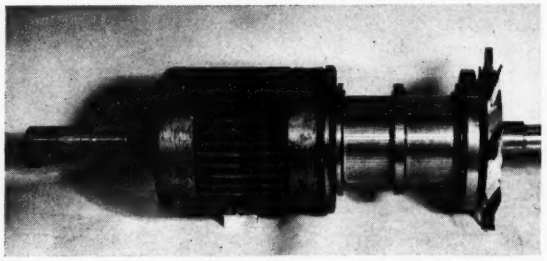


Fig. 4. Armature of high speed d-c generator with shrink ring commutator

sions encountered with operating temperatures. Circumferential expansion in this case is taken care of by the compressibility of the bar mica and the mica between the shrink ring and commutators bars, and between the inside bore of the bars and the bushing.

Of course, at least two shrink rings must be used and if a longer commutator is desired, three or more rings can be used. With mechanical supports located relatively close together, relatively long commutators with several rings can be used for relatively large and high speed commutators. This type of commutator can be built for operating speeds of 2000 to 6000 r.p.m. or higher, depending upon the size of the direct current machine and for peripheral speeds of 10,000 to 12,000 ft. per min. with perfect commutation. Fig. 4 shows a high speed shrink ring commutator.

Like any piece of high speed machinery, direct current motors and generators of the high speed type require more and closer maintenance than slower speed units. Commutator surfaces must be held to close tolerances of concentricity, within 0.001 of an inch for peripheral speeds above 5000 ft. per min., the mica between bars must be kept undercut and the edges of the bars slightly bevelled. Such high speed units must be accurately balanced so that the brushes make good contact with the commutator. The bushing rigging must be correctly adjusted, free from vibration and the bushings must

be free in their holders, the bushing pressure approximately alike for all bushings and of the correct amount.

The higher the operating speed, the better the grade of bushing required. Extremely long bushing life cannot be secured on commutators operating at extremely high speeds since bushing wear increases faster than in proportion to the increase of commutator peripheral speeds, not only due to the higher rate of rubbing action between the commutator surface and the bushing face, but due to the higher rate and more violent action given to bushing vibration from minute irregularities on the surface of a commutator operating at a high rate of speed.

With modern types of commutating brushes and with commutators of the types and constructions described, high speed direct current motors and generators are being successfully built and operated. The sizes of these machines built so far during the past two years at speeds from 2000 to 5000 r.p.m. are from two to four times as great as those built 5 to 10 yr. ago.

Refrigerating Plant Maintenance

Continued from Page 51

sented by the alternate freezing and thawing or defrosting. Coils should not be allowed to become too heavily laden with frost. Not only does this reduce the efficiency of the heat transfer, but it also puts an unnecessary strain on coil hangers. Defrosting intervals are determined largely by the use to which the refrigerated space is put, and it is well to remember that the condition of the coil surface has a bearing on the suction pressure which will have to be maintained. As was mentioned earlier, the suction pressure affects the power consumption directly and the higher the suction pressure can be carried, the more economically will the system be operated. When the proper suction pressure has been determined from a study of the temperature requirements, any difficulty in securing satisfactory results without reducing this pressure usually will be indicative of evaporator troubles.

A convenient method of detecting ammonia leaks is provided by lighting a sulphur tipped stick and passing it around suspected locations. A leak is indicated by the formation of white fumes.

Maintenance of suction pipe insulation is largely a matter of inspection and adequate surface protection. Special precaution should be exercised where insulated lines pass through damp or wet locations and any indication of wet insulation should be investigated and remedied. Under good insulation, suction piping will give many years of faultless service, and removal of the insulation for inspection purposes is not advisable.

Liquid receivers should not be a source of maintenance trouble. All they require is a good coat of paint every few years or so and a clean gage glass.

Brine systems present a few special problems. Paramount among these is that of internal corrosion. Control of the pH of the brine will reduce this source of trouble—not too acid and not too alkaline. The number of clogged brine sprays may be reduced by inserting a good strainer in the supply line. Air in the return brine is undesirable, but so are flies and mosquitoes. As a parting shot at the brine systems—do not, under any conditions, provide a hook-up whereby water may enter the brine system without first dissolving the required quantity of salt. Someone with one of those intentions which pave the road to Hades may admit fresh water into the system and freeze up the best brine cooler.

Correction Note—Calculations on the Three-Wire System

E. B. BENTLEY, assistant manager of the Electric Sales Department of the Cincinnati Gas & Electric Co., has directed our attention to an error in the article, Calculations on the Three-Wire System, which appeared on p. 63 of the June issue. The diagram Fig. 1 is in violation of Kirchhoff's law insofar as the direction of the flow of the current, I_2 is concerned. The current in the middle conductor should flow from C to D. This changes the calculations immediately above, as follows:

$$L_T = 200 - (0.5 + 0.75) = 198.75 \text{ v.}$$
$$L_1 = 100 - (0.5 \div 0.25) = 99.75$$
$$L_2 = 100 - (0.75 + 0.25) = 99$$

and to check, $L_1 + L_2 = 99.75 + 99 = 198.75$.

The final result, it will be noted, is not affected by this change.

NICKEL alloys are being used extensively in hydro projects, valve stems and valve trim of monel having been extensively installed both by the Reclamation Bureau and the Army Engineers. In two new flood control projects in Mississippi, nickel steel has been ordered for the gate operating machinery and a nickel alloy will probably be used for the conduit liners. Stainless clad steel has proved satisfactory for this work at Tionesta and Cripple Creek.

—Photo courtesy of Laminated Shim Co., Inc.

Modern machines require close adjustment of bearing clearances and this photograph shows a workman putting the finishing touches on the connecting rod bearing of a Chicago Pneumatic compressor. The shim is laminated, built up of paper-thin leaves which may be peeled off to give the proper adjustment. Note the babbitt tips designed to prevent lubricant and pressure loss.

RED TAPE — A Curse Or A Blessing

By GEORGE W. DYSON
Consolidated Edison Co., New York, N. Y.

PERHAPS the most popular conception of "red tape" is that offered by the cartoonist wherein a miserable figure sits all tangled up in the meshes of a net woven in more or less haphazard fashion. This figure is usually labelled as government or business and the implication is that the sinuous strands of "red tape" have stifled all initiative and rendered impossible any positive action. Uncontrolled "red tape" to be sure does just that! On the other hand, controlled "red tape" comprises the nervous system of the modern corporate structure.

Perhaps no better way can be found to demonstrate how "red tape" holds together a project of some magnitude than to trace briefly the evolution of a turbo-generator installed in the power house of any public utility.

A public utility is charged not only with maintaining adequate facilities for the supply of electrical energy at any given time, but also with the task of predicting future load growths. It can be well appreciated that a turbo-generator cannot be carved out of thin air. It takes time to design, construct, install and test a unit. In order that the unit be ready to pick up its share of the load at the required time, the executives must have possessed the faculty of pre-vision or indulged in a little scientific guessing. Two things must be borne in mind: first, the unit must be ready when the load demands require it; second, and perhaps conversely, the unit must not be placed in service too far in advance of load requirements because the carrying charges of an investment of several million dollars or so must be taken into account.

Predicting Load Growths

A competent load forecaster must be a many-sided man. He must have the training of an engineer, the background of an economist, and the vision of a seer. In addition to all the foregoing qualifications, he must have a good grounding in *practical* political economy in order that he be able to recognize the ground swells of public opinion. Out of such variables as:

1. Population trends.
2. Business cycles.
3. Existing and contemplated sales policies.
4. Plans with respect to each class of service.
5. The month in which the peak occurs (usually in December).
6. Acquisition of loads formerly supplied by private plants.
7. Development of new applications for the use of electrical energy in industry.

he must formulate a curve which will give the system peak at some future date. Obviously, the value of the above variables will depend largely upon the way they are interpreted.

Now it will be seen that all the above is "red tape" in the commonly accepted sense of the word. It does not boil a pound of water nor does it generate a watt of electrical energy. But it is a systematic attempt to penetrate the veil that hides the future and it is obvious that it is a more reasonable approach than the prediction of future load growths by gazing into a crystal ball.

Once the load growth curve has been established, you leave the realm of the abstract and enter into that of the concrete. Engineers allocate the future load demands to specific sub-stations, determine non-coincident sub-station and area peaks and the resulting coincident total system peak. They, then, determine when and where additional generating capacity will be needed. The next step is the preparation of specifications which will completely describe the unit desired. The final step in this phase of the work is the preparation of estimates which will give a reasonably close idea of the moneys that will be required.

The proposition is then submitted to the executives. Theirs is the responsibility of making the decision based upon the reports of the engineers and financial men. The need of the unit, stressed by the engineers, is balanced against the report of the financial men upon the state of the money market and other financial considerations which are beyond the scope of the practising engineer.

In this particular case, the executives have authorized the construction and installation of a hypothetical turbine; the financial men have given assurance that the money is available when needed; and the engineers have indicated the design of the unit. It is now pertinent to examine the procedure that is to be followed during the actual construction of the unit.

Regulation

The various states have set up Public Service Commissions which regulate the rates which may be charged. These rates are supposed to be so adjusted that after operating, depreciation and tax costs are deducted, enough income will remain to pay a reasonable return on the investment. Further, public utilities are charged with maintaining their books in a manner that will enable the proper authorities to audit them conveniently. In other words we must depend upon some system of "red tape" to keep track of the moneys that are to be expended during the construction of the unit.

This can be done by setting up a system of work orders, i. e., capital, expense and retirement work orders.

The crystal ball method of load growth prediction.

Capital Work Orders

The charges pertaining to the installation of new equipment are placed against the capital work order. For example, the amounts paid to the General Electric Co., Westinghouse or Allis Chalmers Co., for the turbine will be charged to the capital work order, as will the actual installation costs. This equipment will form part of the capital structure and the utility will be entitled to a reasonable return on the investment of money in this equipment.

Retirement Work Orders

Suppose that the new stream-lined turbo-generator has replaced a unit that has reached the age of obsolescence. This unit, however, is part of the capital structure and if the machine is retired, its book value must be subtracted from capital. This is done by charging to the retirement work order the capital value of the machine plus the charges involved in removing the machine less the salvage value of the machine itself.

Expense Work Orders

All charges involved in maintaining equipment are charged against the expense work order. Obviously, in the installation of a new unit there will be no maintenance charges as such. However, during the period of construction it may be found expedient to make certain alterations in the existing plant. These alterations or repairs are charged to expense or "upkeep."

Work orders, in addition to serving as a means of keeping our corporate house in order, provides a means of checking the financial aspects of the job as it progresses. At any given stage, the engineers can make an estimate of the percentage of the work completed. This percentage, considered in conjunction with the accrued charges, will give a very good indication as to whether the actual cost of the job will under-run or over-run the appropriation that has been granted. Unless unforeseen circumstances have arisen during the progress of the job, an under-run or an over-run exceeding ten per cent calls for some tall explanation on the part of the estimators or the construction men. Work orders are also very useful to estimators in that they give a complete financial picture of a job which can be used as the basis for estimating other jobs.

Naturally, all this involves paper work. There are red, pink, blue, green and yellow forms. There are auditors, clerks, and what have you. But they are necessary and, while the average engineer curses with fervor and eloquence, the whole work order system, it is primarily because he does not understand its functioning.

Inventory

Another department of "red tape" that has assumed increasing importance during the last ten years, yes, even the last five years, is the inventory work. The necessity of maintaining continuing property inventory records was only recently imposed upon the utilities and this has increased the complexity of the problem. It has been necessary not only to inventory the new equipment but also to evaluate the old equipment. Further, the plant is never static. It is constantly being altered or having additions made to it. This means that an inventory system must be flexible in order that the lag between the variation in plant equipment and the consequent changes of the records be imperceptibly small. An inventory record is valuable only as it represents the value of the plant today.

The Budget

In a sense the inventory can be said to deal with the past and the present, while the budget deals with the future. Of course, all of you are familiar with the word "Budget". A business concern must maintain a balanced budget if it is to stay in business.

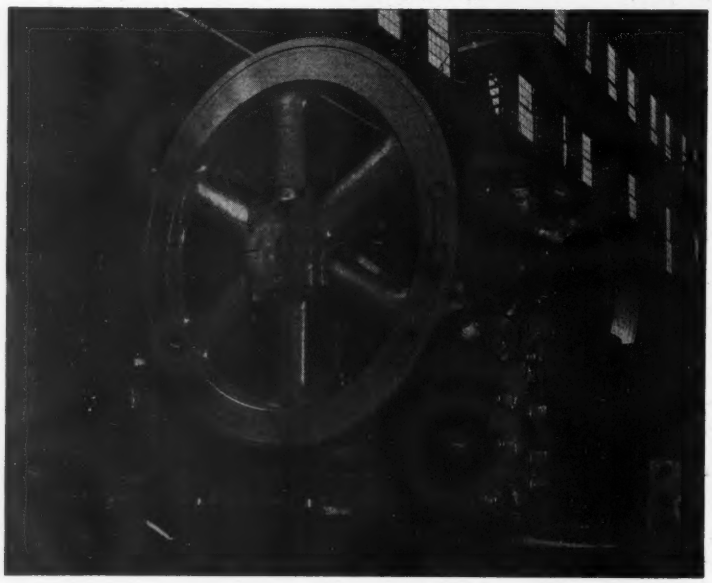
The prepartion of a budget also involves "red tape." It would be tedious to attempt to enumerate all the items that go into the budget of a public utility. The number and magnitude of the items can be appreciated. It can also be appreciated that some one must be charged with the responsibility of preparing the tentative budget for the approval of the executives.

Ed. Note: This is the first of two articles by the author on this subject. In a subsequent article, he will discuss the question of "Scheduling."

PICTURES

Pictured at the left are four hundred of the more than 2500 cage stamping dies used by The Timken Roller Bearing Co. in manufacturing as many kinds and sizes of Tapered roller bearings. First installed in farm wagons and buggies 42 yr. ago, tapered roller bearings now have wide application in automobiles, conveyors and pillow blocks, machine tools; steel, paper and textile mills, printing equipment, shop trucks, ships, farm and logging equipment, mine cars, railroad engines and cars, oil field equipment, and many other uses.

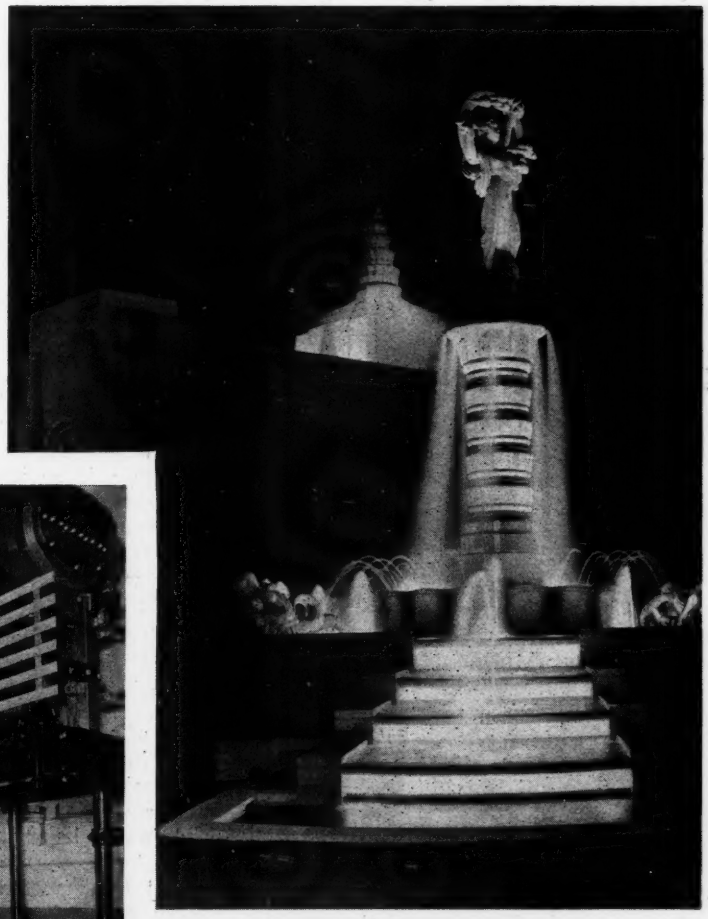
Why go to College? Much emphasis is placed by some upon the value of a college education, but education is not so much a matter of going to school as it is of starting out with proper mental equipment. Certainly, Charles E. Wilson the recently elected President of the General Electric Co. did not need to go to college to bring him to his high position. Mr. Wilson began his business career at the age of 13 as an office boy and never went to college. At the right he is shown receiving the honorary degree of LL.D. at Williams and Mary College, on June 3.

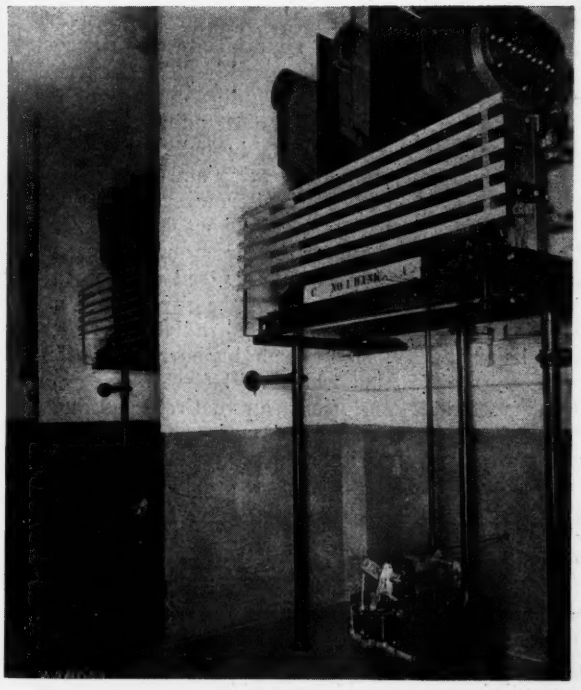


At the left is shown a huge jaw crusher for the Far East. This ponderous unit is one of three all steel jaw crushers with 84 in. by 60 in. openings now under construction in the shops of Allis-Chalmers Mfg. Company in Milwaukee, Wisconsin. These crushers are being built for export to the Far East and will be used to crush iron ore. Each crusher weighs 450,000 pounds. The flywheel in the foreground is over twelve feet in diameter and it, alone, weighs fourteen tons. The large V-belt drive sheave shown on the other side of the machine has twenty-three grooves. It has a pitch diameter of 147 in. and weighs approximately eighteen tons. Note the size of the wrench being used to tighten up the bolts. Although destined for the Far East it is reasonably safe to assume that this little number will not be transported by China Clipper.

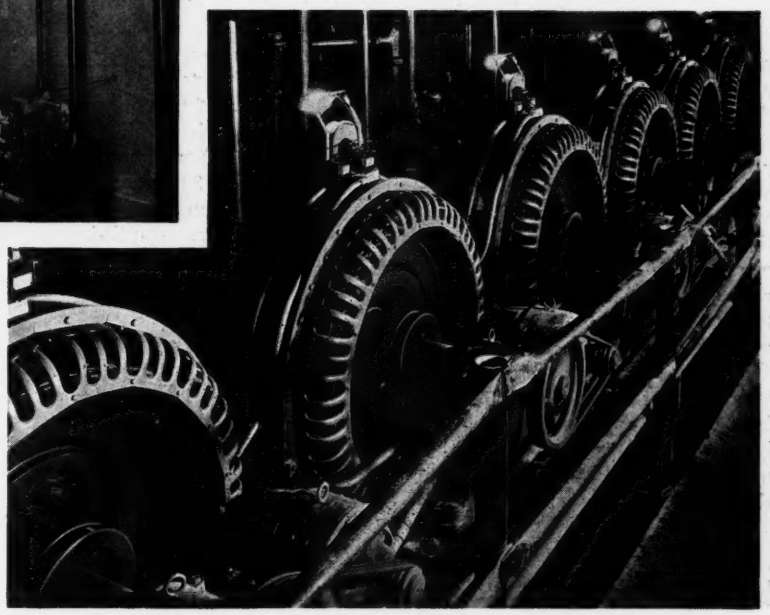
# of Engineering Interest

From San Francisco comes this new picture of the Rainbow Fountain in the Court of Flowers at the Golden Gate International Exposition on Treasure Island. Painted in every hue of the spectrum by night illumination, it is one of the most colorful spots in the 1940 exposition. Attendance figures at the Golden Gate Exposition this year show a steady gain over the record of 1939 according to figures released recently. The comparative statistics for the first month's operation reveal that more than 200,000 more persons passed through the turnstiles this year than last. The beginning of the vacation period has been marked by an increase in the daily average attendance even greater than in 1939.





Above, a view of the Westinghouse air circuit breakers on the 16.5 Kv. distribution circuits of the Southern California Edison Co. at Los Angeles. These breakers have been shown to be safer and less expensive to inspect and repair than previous types.



At the right. A battery of synchronous motors driving paper stock refining equipment at the Cincinnati, paper board mill of the Container Corp. of America. Photo by Torkel Korling.

Continuity Of Service As Related To Its Cost And Value*

A critical consideration of the value of high grade service in terms of what the customer is willing to pay for it. It is pointed out that the cost of extra equipment, refinement in operation necessary in maintaining the high degree of service prevalent in this country are often reflected in higher rates not justified by the added convenience such service offers.

By H. R. WOODROW

Vice President, The Consolidated Edison Co. of N. Y.

WE HAVE DONE a lot of bragging in the public utility business. Most of this, I believe, has been justified; we have a right to be proud of our accomplishments. But I believe that in our enthusiasm we have been carried beyond a sound economic position; we have been emotional rather than objective. In our efforts to make our service more and more reliable, we spend more than the increased reliability is worth to our customers. In other words, *"Tiffany service costs more than John Q. Public wants to pay."*

In the Consolidated Edison system, we have for many years kept records of the system companies of the year by year performance of our several types of distribution systems. Data for 1939 are typical and represent results which have been surprisingly uniform for the past ten years. On the direct current network, six of every one thousand customers have had their service interrupted during the year. In other words, six-tenths of one per cent of our direct current customers suffer a service interruption each year. Putting it another way, on the average, a direct current customer has to wait 166 yr. to have a service interruption. Can you blame him for not waiting? Think of the mental strain—like waiting for the other shoe to drop. If it would happen more frequently, he would get used to it and think nothing of it. Probably he would sleep right through it. But seriously, is it surprising, in view of that record of flawless service, that the customer feels very much put out when it does happen? Is it any more surprising, if he is an important large customer and a potential private plant threat, that our executives also incline to view with alarm and want something done about it right away? I don't think so. I believe it is a perfectly natural, human reaction. But the cost of meeting that reaction may be high.

This tradition of perfect service was carried over into the development of the alternating current network. Before we were permitted to supply load in the important, high load density, business areas of the city, we had to demonstrate that the quality of service that could be supplied by an alternating current system was as good as that which was being supplied from the direct current system. Engineers like a challenge of that kind. We went to work with a will and the record shows that we knocked the spots off the direct current system. In 1939, less than two of every thousand customers supplied from the alternating current network experienced a service interruption, as contrasted with six per thousand on direct current. Three times as good! A few years back I was very proud of this. Now, I wonder. Who wants to wait 500 yr. or more for the lights to go out. I don't.

Of course, the primary motive behind the development of the alternating current network was not improvement of quality of service but reduction in cost of distribution, both investment cost and annual operation and maintenance. Here we accomplished something tangible. Under the conditions existing in New York, the alternating current network, as we have developed it, requires an investment of approximately 75 per cent of that involved in a direct current network, including substations for the latter and excluding generating station costs in both cases. The annual operating and maintenance costs of the alternating current network are only about 60 per cent of those for the direct current system.

In the lower load density, outlying areas of the city we still use the conventional radial or tree system of alternating current distribution which we believe affords our customers an entirely adequate standard of service reliability. Experience shows that on the average, customers served by this system may expect a service interruption every 3 or 4 yr. The cost of this system, where it can be constructed overhead rather than underground, is only 20 per cent of that of an underground alternating current network for the same load density.

If we could only devise some scheme to lengthen that period between interruptions from 3 or 4 yr. to say 30 or 40 yr., instead of jumping to 300 or 400 yr., and without increasing the investment cost more than proportionately, everything would be lovely.

It's a lot of fun to plan a yardstick. I speak from experience. We have devised some perfectly grand schemes for reducing costs of new construction. They all worked fine on paper, A few of them got beyond the paper stage and showed

*Abstract of an address before the Eighth Annual Convention of the Edison Electric Institute at Atlantic City, N. J., June 3-6, 1940.

promise. But most of the time it seemed that for every nickel we knocked off somebody added a dime. For example, after the exercise of considerable ingenuity by ourselves and the manufacturers, a mutually compatible underground transformer and manhole were designed which effected a saving of $300 in the combination, installed and connected for service. Immediately thereafter, but purely by coincidence, the City imposed an annual rental on the space occupied by transformer manholes, the capitalized value of which is about $900 in Manhattan and $450 in the other boroughs of the city. Sharpen our pencils as we will, we haven't yet figured a way to get back to where we were before we started. Incidentally, the city collects more than $450,000 a year from us on that little item. There is no expense at all incurred by the city in connection with these rentals because we still pay the same permit and inspection fees in vogue before the idea of space rental arose. Happy are those yardstick planners who don't have to worry about such trivial matters.

The alternating current network is one of our own yardsticks, designed for purely local use to take the measure of our direct current system. It served its purpose but it was a lot better on paper than in actuality and I don't mean it was planned by wishful thinking. We just could not foresee the effect of a few factors which the crystal gazers, including myself, felt had been taken care of. There being no rubber in our yardstick, we added a few inches.

Take the matter of reserve capacity in the system. We originally planned on maintaining satisfactory service voltage and on conservative short times overload on transformers with one feeder out of service. Now, and for some years past, we have been designing for a coincident outage of two adjacent feeders. This results in an increase of about 20 per cent in investment cost and is also reflected proportionately in the cost of maintenance and operation.

How did we happen to make that mistake? Simply, by the usual yardstick method of assuming that conditions are comparable when they are not. Our low voltage direct current feeders were short and carried loads of a few hundred kilowatts. Our high voltage alternating current feeders are long and carry loads of several thousand kilowatts. What difference does that make? Well, here's the story.

Not only has New York City a large population but it also has a rapidly increasing population which means continual load increase. There is also rather large and continuous shifting in load centers which require rearrangement of facilities.

All of these factors mean that feeders are frequently taken out of service to connect additional transformers for new load, to disconnect transformers no longer needed at a location, to rearrange or relocate cables because of load growth or physical interference with other projects. Longer feeders, more exposure and more load affected. Hence, the necessity for more insurance in the form of additional feeders and transformer.

Another aspect of quality of service enters the picture at this point, namely, voltage regulation or steadiness of voltage. As a result of our direct current background and the tradition of perfect service it established, we have had to live up to very exacting standards of voltage regulation on our alternating current systems. We initiated these standards, we boasted about them, everyone takes them for granted and we dare not relax. In most parts of our distribution system, the number and capacity of transformers and mains cables are determined by the minimum voltage limits rather than by the ability of the equipment to carry load. We have estimated that reducing the minimum voltage limits by as little as two volts would reduce the required capital investment in distribution facilities in many areas by as much as five to ten per cent. While it may be out of the question to reduce our voltage standards in the highest load density areas, it is unfortunate that these exceptionally high standards have been carried over into districts where they are not strictly necessary. But our customers and the regulatory authorities have been educated to expect the same high standards of voltage in all parts of our system.

By means of graphic voltmeters located at strategic points on the system, supplemented by spot readings taken by our service men incidentally to their work, we know how terribly good our voltage is. On the direct current network, data were taken at 2876 locations during 1939. At 99.86 per cent of these locations, the service voltage was within the normal range of plus or minus four volts, 96 per cent were within plus or minus two volts, 77 per cent were within plus or minus one volt, and 38 per cent were right on the nose. Figures for the alternating current network are almost identical with those I have cited for the direct current system. Figures for the radial system are about ten per cent lower. It seems to me one is giving pretty good service if only ten per cent of the customers

DOES THIS APPLY TO YOU?

In presenting his case, Mr. Woodrow is of course concerned primarily with public utility operation. Whether his criticism is justified or not, it will have to be admitted that it costs the utilities, especially the utilities in our large metropolitan centers, a great deal to provide the high grade of service that they do provide. Aside from the interest of Mr. Woodrow's argument to public utility executives and engineers, we feel that there are elements in it that apply with equal force to private plant operation. In industrial plant operation, continuity and reliability of service are admittedly of great importance but after reading Mr. Woodrow's article we asked ourselves to what extent his argument holds in the industrial plant field. Are all the elaborate arrangements often installed in industrial plants in insure uninterrupted service entirely justified? Where all the facts have been taken into consideration, and the cost of loss of production carefully balanced against the investment charges the answer is clear, but where such careful studies are not made from time to time, many of the provisions incorporated in modern plants to insure unfailing service may well be liabilities rather than assets. Ed.

are getting voltage outside of an arbitrarily chosen range of plus or minus four volts. It is hard to justify that last ten per cent of perfection on economic grounds.

Voltage complaints serve as another index of quality. We have about 2,300,000 customers on our system. During 1939 we have a record of only 1,955 complaints representing less than one-tenth of one per cent of our customers, which could be classified as complaints of high voltage, low voltage and fluctuating voltage. I think there must be something wrong with us that we get such a small percentage of complaints, but even more significant, of that total of 1,955 only 253 or about one-seventh were found to be justified upon investigation. From these results I can't believe that we are rendering the most economical service which would be satisfactory to our customers.

The Good Samaritans

In the course of a voltage survey one of the customers in an outlying section was found to have 95 volts but had made no complaint. In customary Edison fashion, trucks, men and equipment arrived and the voltage was brought up to normal. Everybody sat back with the day's good deed done awaiting the expression of the customer's good will. It arrived one month later in the form of a high bill complaint.

Of course, we never can know how many of our customers grin and bear it without complaining, in spite of the encouragement they have had in the last few years to become vocal. But we do know that those who complain are usually very reluctant to spend any of their own money to correct the situation if it is due to conditions on their own premises. Perhaps this is a significant measure of the value they attach to continuity and steadiness of voltage.

We have also found that at the time of an outage, many radial customers seem willing to spend the necessary additional money to utilize multiple services, but after a day or two of calmer reflection on the value of this improved service to them or maybe after a glance at last month's statement of operations they change their minds.

One customer located in an exclusive residential area was supplied by a radial transformer which also supplied two other residences that were closed for the summer. Three days after a lightning storm the customer called and told the Company that she knew that the storm had been severe and we undoubtedly had a lot of trouble because of it, but she felt that we ought to get around to restoring light to her house soon. An immediate investigation showed that a primary fuse had been blown during the storm.

The same factors and the same philosophy which I have discussed as responsible for high costs of distribution are also responsible for extra costs in generating stations. It has been our practice to maintain a generating reserve of three units instead of two units or even one unit, which is representative of common practice; to provide enough tie feeder capacity to permit the loss of two generating units in any generating station rather than one unit; to provide miscellaneous refinements in the construction of generating stations, such as segregated or duplicate supply to auxiliaries, spare boiler feed pumps and coal handling equipment, etc.; to provide facilities for flood control at our generating stations to take care of a contingency which has occurred only once during the existence of the Weather Bureau; to rebuild switch galleries in generating stations because once we had a station shutdown; to keep two men on a watch, in additional to a helper and, in some cases, a foreman, rather than one man in the substations.

The items just mentioned increase the cost of electric supply and it is questionable if the added reliability is justified. Electric companies are under constant pressure by regulatory authorities to maintain the utmost in service reliability and at the same time they are constantly pressed to reduce rates.

Entirely apart from the value attached to high quality of service by different groups of customers and the cost to the Company of supplying such service, the inherent cost of our system is influenced greatly by the load density and the degree of street congestion. Also, in New York City, the greater part of the load is necessarily served from underground distribution systems. Overhead distribution is entirely out of the question in any part of Manhattan and in parts of Queens, Brooklyn and the Bronx. Everyone knows that underground systems are costly. You know as well as I that underground distribution requires several times the capital investment necessary for overhead distribution. The cost of underground distribution would be prohibitive were it not for the high load densities in New York City.

I have attempted to bring out some of the reasons for the cost of our superlatively good service and I would like to leave this thought with you. Consider most carefully any proposed type of construction or system which will increase your fixed charges or operating costs, and be as certain as possible that the value to your customers of the improvement will more than offset the increased expenditure. We can always do a better job than we are doing but this usually involves some increase in cost, and the question to be determined is whether or not it is worth it.

Creep Tests

DISCUSSING high temperature rupture and creep tests before the June meeting of the A. S. T. M., E. L. Robinson of the Turbine Engineering Dept., General Electric Co., said that consideration of these test results leads to several questions difficult to answer without years of actual service including service severe enough to indicate what type of distress must be expected. It seems plain that materials put their best foot forward and hang together better for a year or two than for much longer periods of time.

Actually when treatments are varied the rupture strength is affected much less than the creep strength. Thus if working stresses are set with reference to a low creep strength material, the rupture strength may be 4 times the working stress. On the other hand, if the treatment is varied to improve the creep strength, the rupture strength may turn out to be no more than double the nominal creep strength and some tests show the margin to disappear entirely.

Ignition Characteristics of Diesel Fuels

By ROBERT F. SELDEN
Langley Memorial Aero. Lab.*

IGNITION-LAG data were obtained for seven fuels injected into heated, compressed air under conditions simulating those in a compression-ignition engine. Earlier tests with the N.A.C.A. high-temperature bomb show that the ignition lag at the highest bomb temperature is roughly twice that for the same fuel in an N.A.C.A. high-speed Diesel engine having a comparable air density at top center. The minimum engine ignition lags reported by others are in substantial agreement with those obtained with the bomb.

It has been reported that the C.F.R. fuel ratings are in substantially the same order when either the critical-compression-ratio (C.C.R.) or the ignition-delay method is used. The fact that the C.C.R. method involves longer ignition lags than the delay method indicates that the bomb would also give comparable ratings provided that the greater air turbulence in the engine was not an influential factor.

On this basis, tests were made in the bomb with fuels of different ignition qualities, or different cetane numbers, to determine the limitations of this apparatus for rating fuels. The test conditions included bomb temperatures of 870 and 1155 deg. F. and air densities of 0.59, 0.89 and 1.18 lb. per cu. ft. The engine data with which these results are compared were obtained with an N.A.C.A. displacer-type compression-ignition engine at 2000 r.p.m. and a compression ratio of 14.5.

Fuels Tested

Seven fuels were tested in the bomb, three of which were obtained by adding an ignition accelerator to a single base fuel designated as L_1 Diesel in the figure. Ethyl nitrate was used for two of these fuels and a commercial Diesel dope for the third fuel. The four other fuels used in the bomb were selected from among eight fuels tested in a compression-ignition engine.

The ignition lags obtained both in the bomb and in the N.A.C.A. engines depend upon a slight increment of pressure to denote ignition; whereas the cetane numbers cited depend upon an ignition denoted by the attainment of a certain rate of pressure rise after ignition. The two methods can give comparable results only if the rate of pressure rises and the smallest detectable pressure increment are determined by the true ignition lag and are not influenced by the viscosity, the surface tension, the distillation characteristics, or other physical properties of the fuel.

Bomb records obtained in this study would be ideally suited to test the validity of this point were it not for the fact that their pressure and time scales are too condensed to permit an accurate determination of the initial rates of pressure rise. That the lags and the cetane numbers for the usual range of Diesel fuels are in general agreement is indicated by the small deviation in cetane equivalent from one ignition-indication method to another.

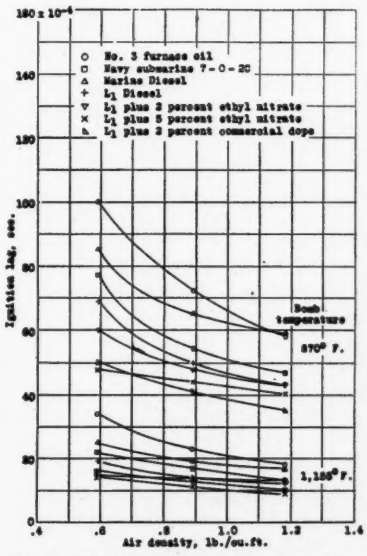


Fig. 1. Effect of air temperature and density on ignition lags in a bomb

The curves show the same tendency for the ignition lags of all fuels to converge with increasing air densities and temperatures as they do with a decreasing injection advance angle. When ignition occurs before top center, decreasing the injection advance angle is equivalent to using a constant advance angle and increasing the compression ratio which, in turn, is equivalent to increasing the air temperature and density in the bomb.

In addition to the relative ignition-lag order for fuels under specified engine conditions, the change in this order with decrease in compression density and temperature may become of interest in the rating of fuels for aircraft Diesel engines required to operate above the critical altitude of the engine. This change in the bomb rating order with air density is illustrated by the curves that cross.

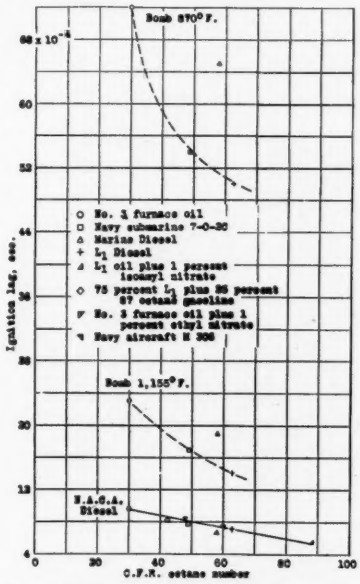

Bomb 870° F.
No. 3 furnace oil
Navy submarine 7-0-20
Marine Diesel
L_1 Diesel
L_1 oil plus 1 percent isoamyl nitrate
75 percent L_1 plus 25 percent 87 octane gasoline
No. 3 furnace oil plus 1 percent ethyl nitrate
Navy aircraft H 308
Bomb 1,155° F.
N.A.C.A. Diesel
Ignition lag, sec.
C.F.R. cetane number

Fig. 2. Comparison of N.A.C.A. engine and bomb ignition lags

The engine and bomb data show that the lower the temperature, the greater is the variation in ignition lag per cetane number, particularly in the lower cetane region. Other conditions being equal, therefore, the higher the effective air temperature and density in an engine, the less sensitive that engine should be to the ignition quality of the fuel. With the exception of the Marine Diesel fuel, the rating order obtained with the bomb was the same as that with an engine.

*Complete details of this investigation reported in N.A.C.A. Technical Note 710.

—International News Photo

WENDELL L. WILLKIE —Man of the Hour

A Hoosier lawyer who worked up to the top of his profession, became head of a utility empire, forced by circumstances to lead an industry in the political arena, almost overnight finds himself a national leader and an international celebrity.

WHILE INAUGURATION speeches were still ringing in Washington early in 1933, Wendell L. Willkie became president of the Commonwealth & Southern Corp., a combination of events apparently arranged by the Fates to sweep him with metamorphic precision from a comparatively unknown lawyer to a chivalrous champion of the holding companies, Number One front man for the utility industry and finally into the maelstrom of politics at one of the most troubled periods in world history.

While the entire industry was alarmed at the New Deal power policies, the Commonwealth & Southern Corp., with the subsidiary Tennessee Electric Power Co. operating in the Tennessee River Valley, was the only one directly affected by the early formation of the TVA. This he fought practically single handed, vainly exhorting an apathetic industry, trampled by the depression and discouraged by financial failures, to rally to his support. It was not until the holding company bill, with its so-called "death clause", was well under way that he received any appreciable assistance. Even this never came up to the Willkie standard because many in the industry felt that an aggressive campaign would lead only to retaliatory measures from the administration.

Undaunted, Willkie continued. The holding company bill passed in 1935. Willkie beaten but unbowed, continued to fight on. Commonwealth & Southern proceeded with voluntary integration of its system to affect economies but Willkie has continued his efforts to resist certain provisions of the act and interpretations of the Securities & Exchange Commission.

The TVA battle, something more of a local affair, ended like the battle of Jutland. Willkie was forced out, lost his properties, but the retreat proved costly to the opposition. In his retreat he carried along $78,600,000, a compromise price considerably above the original $67,000,000 TVA offer and sufficient to clear up outstanding indebtedness and give the common stockholder something over $14 a share.

Willkie entered the battle in 1933 an experienced corporation counsel, he emerged in 1939 an experienced politician, a capable executive, a skillful lobbyist, and an able organizer. This rigorous schooling under adverse conditions gradually changed the fight from an impersonal legal affair to a personal matter involving fundamental principles of government. He developed into the most insistant, persistent, rational and logical of all the New Deal critics.

If it had not been for the interests of others involved it is likely that Willkie would have enjoyed the fight equally well,—win, lose or draw. Bluff, friendly, informal, aggressive and combative, he argues with a ready wit, good humor, evident appreciation that any argument has two sides, and with a relish which indicates that it makes little difference which side he is on, or what the subject is, so long as he has a capable antagonist. Those who heard him on the Town Hall radio program a few months ago know that he is capable of holding his own on any subject from Fairy Tales through classic literature, science and philosophy, to law.

Over six feet tall, he appears lanky on the speakers' platform in spite of his 200 lb. He dresses neatly, well and conservatively, but with a careless abandon which with his unruly mop of hair, speech and mannerisms suggests a shrewd Hoosier farmer, a pose which he cultivates and not altogether without justification for he farms, by proxy at least from his New York apartment, over 1400 acres in Indiana.

While not an orator, he speaks eloquently with logical sincerity that persuades and a histrionic ability that makes one feel that the stage lost a great artist to the bar. In fact the Willkie personality is such that there is no question that he was destined for success in any walk of life he might have chosen.

Apparently this is a family characteristic. One of his three brothers, Ed, a former All-American tackle at Annapolis, is vice-president of Libby, McNeill & Libby and lives at La Grange, Ill.; Fred is vice-president of Seagram's at Louisville, Ky., with Bob as his assistant. The elder sister, Julia, is an analyst at a winery at St. Catharines, Ont., and the younger sister, Charlotte, is the wife of Lt. Com. Paul E. Pihl, naval attaché at the American Embassy in Berlin.

The father, Herman Willkie, of German extraction was a lawyer at Elwood, Ind., and the mother, Henrietta, the first

woman lawyer admitted to the Indiana bar. The Willkie household boasted a library of several thousand volumes and is said to have been conducted in a very informal manner. Undoubtedly many of the "I remember" stories current today are fiction, but, the Puckish small boy twinkle and expression which Willkie often has even today indicate that many of the stories may well have some basis of fact.

EDITOR'S NOTE: *Since its inception almost half a century ago, it has been the policy of Power Plant Engineering to avoid partisan issues, to confine its activities to the technical and news side of power generation and utilization, and to take cognizance of political matters only on a non-partisan basis infrequently when impending legislation, detrimental to the industry as a whole or engineers as a class, was involved. This policy has been rigidly adhered to and the present article is not political, it is neither a defense or criticism of Mr. Willkie, his views or his politics, but simply a news article of a man and his work, the first man in the utility industry to receive such exalted recognition, a man who until a few weeks ago was practically unknown to the public as a whole.*

With such an inheritance and background at least one of the family was certain to be a lawyer (one of his sisters also studied law), and the choice fell to Wendell who was always active in school debates and in 1909 acted as toastmaster at a school banquet. Born on Feb. 18, 1892, in Elwood, Ind., he graduated from high school there in Jan., 1910, shortly before his 18th birthday. His report card for the four year period showing 17 E's, 5 G's and 9 P's, a suggestion of a C or condition mark on his card during the first year and a preponderance of E's in the last two years indicate that as a beginner he did not take school too seriously.

He received his A.B. from the University of Indiana in 1913, attended Oberlin College a while but returned to Indiana U and received his LL.B. in 1916 and the honorary degree of LL.D. in 1938. It was while working during his college career that he received such a varied, albeit sketchy knowledge of many industries in widely scattered sections of the country. Among other things he taught school at Coffeyville, Kan.; milked in a dairy in Wisconsin; worked in the steel mills in Chicago; picked cucumbers in California; cooked in a Colorado tent hotel; did farm work and sold newspapers in Indiana; harvested in Minnesota; worked in the oil wells of Texas and a cement plant in Wyoming.

While in college he was somewhat of a socialist, fierce in his defense of labor unions and the underprivileged but apparently not enough of a radical to make him unpopular for he was elected senior law class orator. It is somewhat ironic that Willkie, with liberal and socialistic tendencies in college, a life-long Democrat, still listed as such in the 1938-1939 edition of Who's Who in America, should because of so-called liberal policies be forced to oppose the Democratic party in 1936 and now lead the opposition.

In 1916 he returned to Elwood, Ind., was admitted to the Indiana bar and practiced law with his father under the firm name of Willkie & Willkie. This experience was cut short by the war, however. Wendell enlisted immediately in the artillery and served 11 mo. overseas and rose to the rank of captain. Before sailing for France he married Edith Wilk of Rushville, Ind., on Jan. 14, 1918. They have one son, Philip, until recently a student at Princeton.

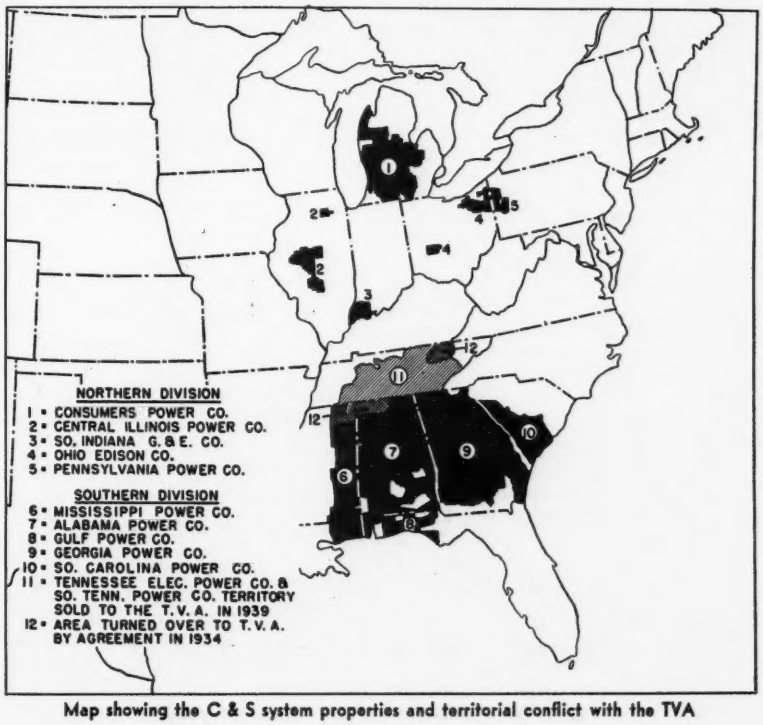
Home after the war, he considered politics but finally took a job with the Firestone Tire & Rubber Co. at Akron, Ohio. He was admitted to the Ohio bar in 1919 and soon went into private practice there as a member of Mather, Nesbitt & Willkie. In 1929 he went to New York as a member of the firm Weadock & Willkie, was admitted to the New York Bar in 1930 and continued as counsel for the Commonwealth & Southern Corp. until he was elected president in 1933 upon the retirement of B. C. Cobb, Chairman of the Board and President.

The Commonwealth & Southern Corp. was incorporated in Delaware in May, 1929, as a holding company organized by Bonbright & Co. around a nucleus of public utility properties which was later extended and now includes the 10 properties shown solid on the accompanying map. Before the loss of the Tennessee properties the assets of the company were well over a billion dollars, the generating capacity over 2,000,000 kw., about half in hydro, serving an urban and rural territory with about 10,000,000 population.

As soon as it was started, the TVA conflicted with the territory of the Commonwealth & Southern System[1] and by an agreement signed in Jan., 1934, sections in northeast Tennessee, northwest Alabama and northeast Mississippi were turned over to the TVA for $2,900,000 with an operating and power exchange arrangement running until Dec., 1938. After a long and bitter fight with $67,000,000 offered and over 90 millions asked, a compromise price of $78,600,000 was fixed as the sale price of the Tennessee Electric Power Co. and So. Tennessee Power Co. properties and the agreement signed in August, 1939. Through an intermediate mediate corporation, the Tennessee Utilities Corp., set up for the purpose generation and transmission facilities were sold to the TVA for approximately $44,000,000 and the distribution facilities to some thirty communities. Nashville will pay $14,000,000, Chattanooga $11,000,000, with the balance distributed among the others.

On July 10, Willkie resigned his $75,000 a year position as President of the Corporation in order to devote his entire attention to the campaign. On July 17, he was succeeded by Justin R. Whiting of New York, member of the legal firm of Weadock & Whiting, counsel for the Commonwealth & Southern Corp. Mr. Whiting, born in Michigan in 1886 and a graduate of the University of Michigan with the degree of LL.B. in 1907 has been connected with the corporation or its predecessors since 1912.

[1]For a more complete review of the generating facilities of the Corporation and recent additions, see the first of a series of articles "Modern Utility Stations, I. The Commonwealth & Southern System" by Geo. C. Daniels, Chief Mechanical Engineer, POWER PLANT ENGINEERING, p. 164, March 1938.


NORTHERN DIVISION
1 • CONSUMERS POWER CO.
2 • CENTRAL ILLINOIS POWER CO.
3 • SO. INDIANA G. & E. CO.
4 • OHIO EDISON CO.
5 • PENNSYLVANIA POWER CO.
SOUTHERN DIVISION
6 • MISSISSIPPI POWER CO.
7 • ALABAMA POWER CO.
8 • GULF POWER CO.
9 • GEORGIA POWER CO.
10 • SO. CAROLINA POWER CO.
11 • TENNESSEE ELEC. POWER CO. & SO. TENN. POWER CO. TERRITORY SOLD TO THE T. V. A. IN 1939
12 • AREA TURNED OVER TO T. V. A. BY AGREEMENT IN 1934

Map showing the C & S system properties and territorial conflict with the TVA

High Speed Turbines Improve Efficiencies

Noted turbine design engineer, reviews the trend of turbine design in recent years before the A.S.M.E. convention in Milwaukee and shows that the trend towards higher speeds has permitted a better use of materials with resulting gain in efficiency.

CONTRARY to the preconceived ideas of many engineers, operating experience with both land and marine units seems to indicate definitely that the newer high-speed turbines are more reliable and more economical than the older slower-speed machines, according to Glenn B. Warren, turbine design engineer for the General Electric Company.

Speaking at the semiannual meeting of the American Society of Mechanical Engineers at Milwaukee (June 17), Mr. Warren pointed out that the trend to higher speeds has permitted a better use of materials in turbines and has lowered investment and operating costs under what they would have been had speeds not been increased.

The trend toward higher turbine speeds has been dictated by a number of factors. First is the question of efficiency. In the second place, however, and perhaps of even greater importance, is the fact that it becomes very much easier to build reliable turbines for high pressures and temperatures if the shells and rotors and interstage diaphragms are kept as small as possible. This can be done in higher speed turbines.

Mr. Warren presented the accompanying curves summarizing the statistics of turbine progress which he said pointed to the following conclusions:

(a) Although the largest possible unit at any given speed has steadily increased, and the large units have been effectively utilized in reducing operating and fixed costs on the large utility systems, the average size of unit sold in the U. S. (units above 10,000 kw. considered) has increased but slowly.

(b) Increases in maximum pressure and temperature have been followed by a steady rise in the average pressure and temperature for which machines have been sold, thus certifying to the fact that the pioneering done by a few power plant owners has been followed by an advance in the entire industry.

(c) These facts are further attested by the almost continuous downward trend of the fuel consumption both for the best plants available and the somewhat similar trend for the average. Reduction in coal consumption of the best plants is due to the progress which has continued during the last few years, whereas the continual reduction in the average is due to the taking over of the load by newer and more efficient stations as they are installed from year to year, and to the relegating of the older and less efficient plants to peak load and stand-by service.

The business depression of the early thirties reduced the number of new plants being installed, although the growth of the electrical load has continued. This resulted in an increasing use of many older and less efficient plants with a slowing up of the year-by-year reductions in the average coal consumption per kilowatt-hour. With the resumption of the power plant building program now under way, we should see still further reductions in the fuel consumption per unit of output.

Four Principal Elements of Progress

The progress of turbine design and construction since its inception according to Mr. Warren has consisted largely in:

1. Building turbines and the attached generators of higher unit capacities to meet the growing demands for more power, and so permit reduction of plant investment per unit of output.

2. Continuously modifying and refining the design, manufacturing processes, and materials used in order to increase the reliability of operation and to reduce the outage time which has always been one of the chief concerns of operators of such equipment.

3. Utilizing higher initial steam pressure and temperature, coupled with improved heat cycles, such as regenerative feedwater heating, resuperheating, air preheating, etc., to decrease the fuel consumption per unit of output.

4. Designing the turbine to utilize an ever-increasing proportion of the available energy in the steam cycle being used at the time.

The decrease of over-all plant investment through greater reliability of the turbine-generator, and the decrease in investment and operating costs resulting

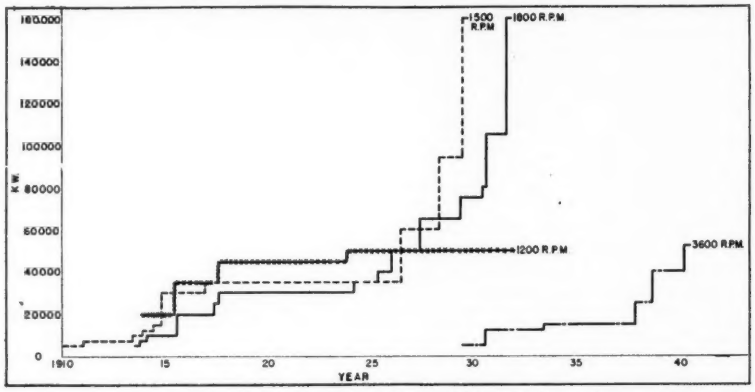


Fig. 2. (Above) The maximum capacity per unit of condensing turbines

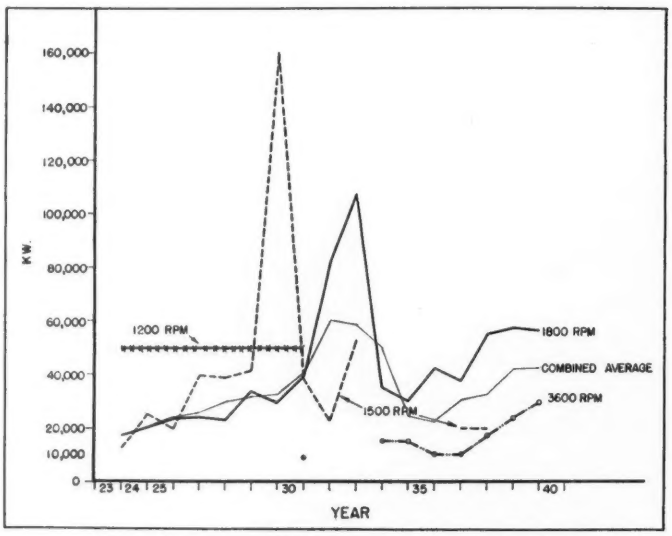


Fig. 1. The average turbine capacity per unit since 1923

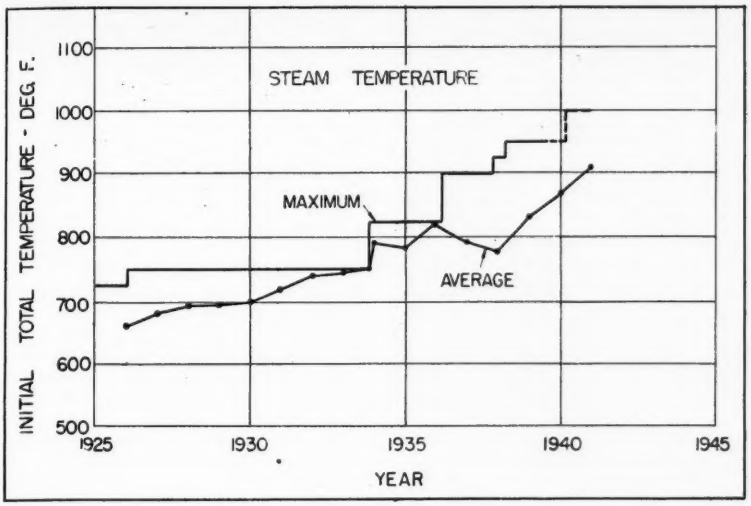


Fig. 3. Graphs showing the trend in steam temperatures during the fifteen years between 1925 and 1940. Note how the average caught up with the maximum around 1934

from improved efficiency have always been of much greater significance to the owners of such equipment than the reduction of first cost of the turbine and generator alone.

The major endeavor, therefore, has been to improve these two factors through the use of new knowledge, new materials, and new tools and manufacturing processes.

Hydrogen-cooling has made possible larger 3600-r.p.m. generators, and has within the past few years permitted building many turbines for the 3600 r.p.m. rather than 1800 r.p.m.

Warren said that he believed that turbine speeds for generator drive have probably reached a limit at 3600 r.p.m. with 60-cycle power being generated.

Although new electrical devices may change this situation, it does not appear to be in the immediate future, and new development should be stabilized at this speed, which will probably be an advantage for all concerned.

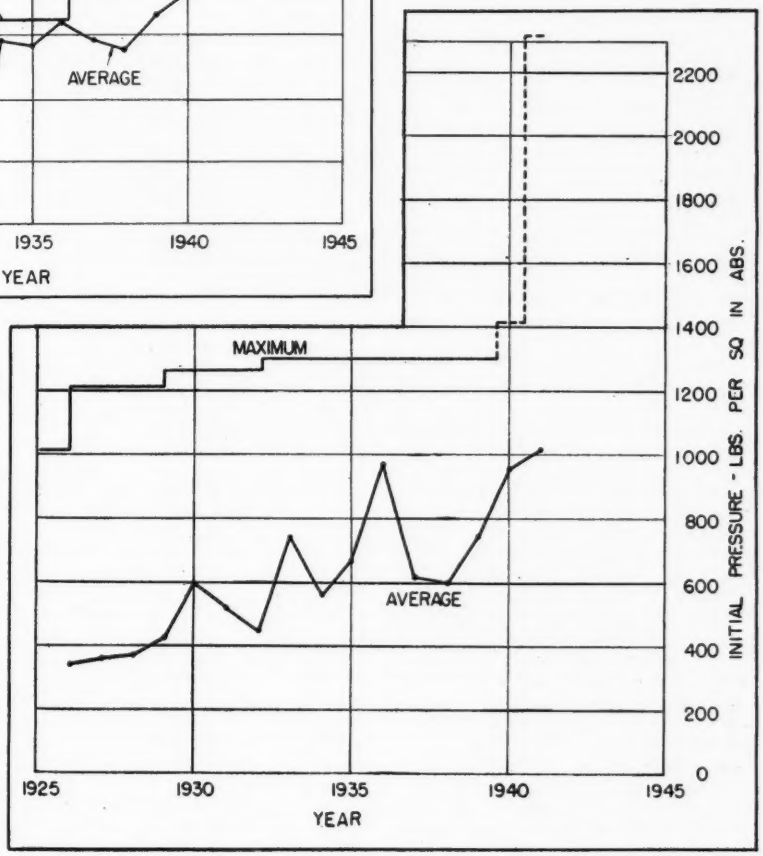


Fig. 4. (Above) In this chart are shown the average and the maximum initial steam pressures used on turbines from 1925 to 1940. Contrasted with the trend in steam temperatures shown in Fig. 3, the maximum pressure has kept well above the average during the entire period covered. The dotted portion of the curve shows the maximum to be obtained with turbines now under construction.

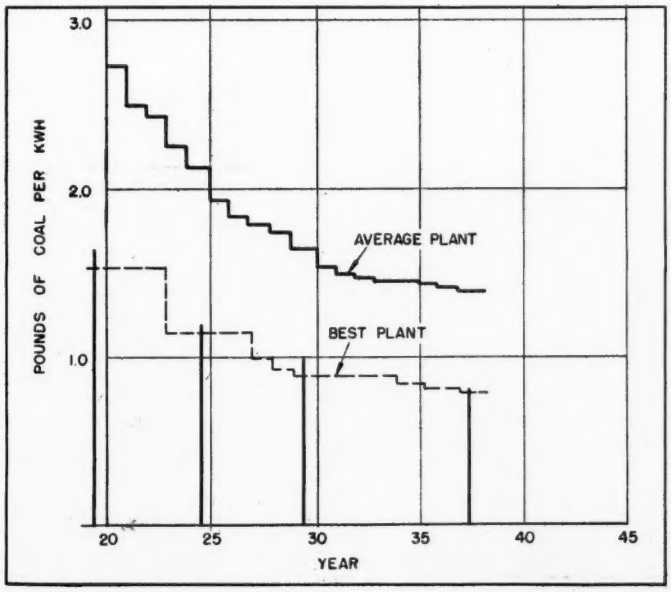


Fig. 5. (Left) Graph showing the amount of coal consumed per kw-hr. generated in the best plants as compared with the consumption in the average plant during the period 1920 to 1940

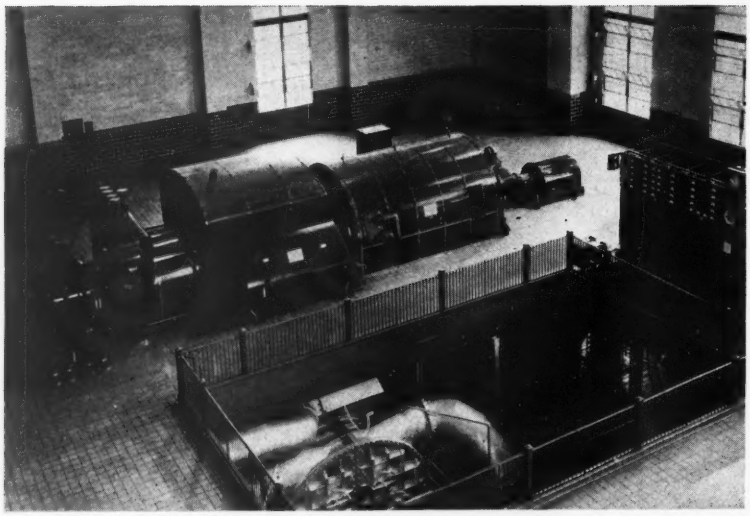


Fig. 1. The first of the two 35,000 kw. G. E. hydrogen-cooled generating units. The installation of the second will begin in a few months

Consumers Power Dedicates Weadock Station

CONSUMERS POWER COMPANY'S new steam power plant, the John C. Weadock Station at Bay City, Michigan, was dedicated June 20 with Wendell L. Willkie, president of the Commonwealth & Southern Corporation, the principal speaker in the ceremonies. John C. Weadock, distinguished former Bay City attorney for whom the plant is named, responded. For some years Mr. Weadock and Mr. Willkie were partners in the New York law firm of Weadock and Willkie.

The plant was opened for public inspection during the afternoons and evenings for the four days, Thursday through Sunday, immediately following the dedication. Thousands of visitors took advantage of the opportunity to learn how the plant translates the energy of coal into that of electricity.

Present 35,000-kw. capacity of the Weadock station is furnished by a General Electric hydrogen-cooled generator and two 400,000 lb. per hr. 900 deg., 900 lb. Foster Wheeler boilers. This boiler installation is of sufficient capacity to carry a second identical G-E turbine-generator to bring the plant's capacity up to 70,000 kw. Installation of the second unit is to begin within a few months.

Situated on the tip of land where Lake Huron and the Saginaw River meet, the plant has ample room for expansion and unlimited coal storage space. The latter is essential because the river is frozen from November until April and sufficient coal must be stored to last through the season. The coal will be brought up the river in 12,000 ton self-unloading boats, the largest boats on the lake. Condensing water is taken from the river and discharged into Saginaw Bay. The station is served by a 275 ft. stack, 21.5 ft. in diameter at the bottom and 17 ft. at the top.

The electric generating unit now in operation is a 21-stage, tandem-compound turbine designed for a steam pressure of 800 lb. and a steam temperature of 850 F. There are eight valves under governor control which admit steam to the first stage nozzles and two overload valves also under governor control which admit steam to the first stage shell. After passing through the eighteen stages comprising the high-pressure cylinder, the steam is passed to the low-pressure cylinder which consists of three double-flow stages. The low-pressure cylinder is enclosed by the exhaust hood. The coupling between the turbine and the generator is enclosed in the low pressure cylinder. Steam is extracted at the outlets of the 8th, 12th, 16th, and 19th stages. With full load operation, the corresponding pressures at these extraction points are 140 lb., 65 lb., 25 lb., and 7 lb. absolute.

The generator operates at a speed of 3600 r.p.m. Field excitation current is obtained from a 160-kw. exciter and a 6-kw. pilot exciter driven from the main generator rotor through approximately a 2 to 1 reduction gear. Cooling of the hydrogen gas is accomplished by four fin-type, cooler sections, two on each side and located inside the stator frame. About 360 gallons of cooling water per minute are required. To prevent the loss of gas, a special oil seal is provided within each bearing, the oil supply to the seal being independent of the bearing oil supply and special detraining apparatus provided for reclaiming the gas from the return oil. About 1,100 cubic ft. of hydrogen is required to fill the generator. Purity of the hydrogen is maintained by admitting gas as required during operation, a positive pressure of about 8 in. of water being maintained at all times to insure that no air is drawn in. The generator can be operated with air as the cooling medium, but its maximum load is then limited to about 50 per cent of the maximum capacity of the unit.

Power generated at the Weadock plant will flow into the Consumers statewide interconnected transmission system.

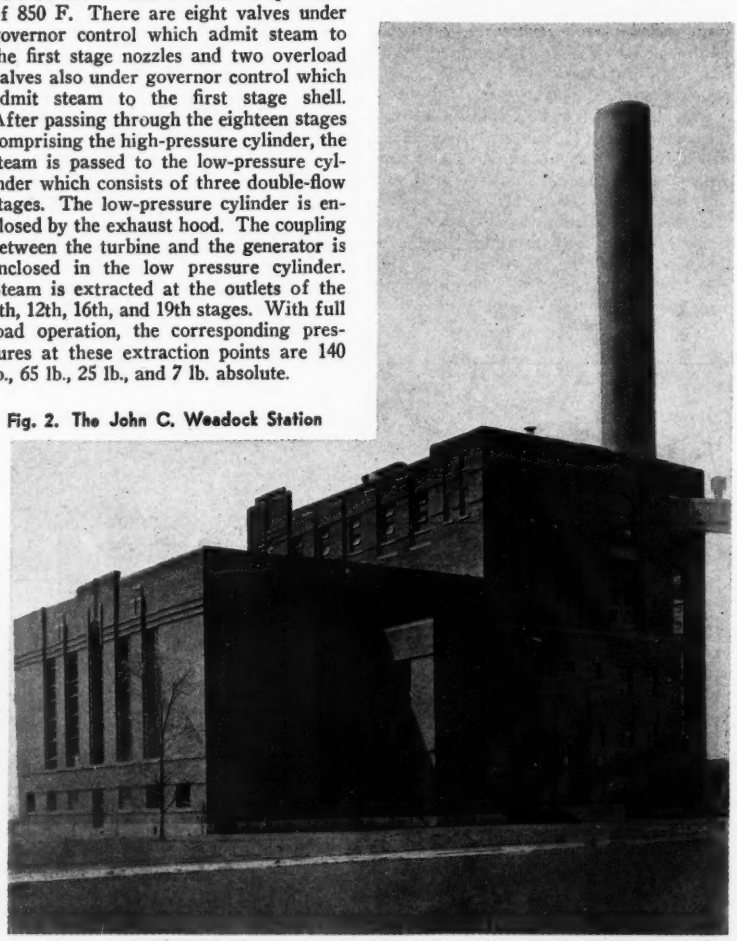


Fig. 2. The John C. Weadock Station

The PRACTICAL ENGINEER and ELECTRICIAN

RALPH E. TURNER, EDITOR

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THE INFORMATION MACHINE

It has always been the ambition of the editors of POWER PLANT ENGINEERING to give to its readers not only the information published in the magazine but personal answers direct by mail to questions dealing with power plant practice. While this service has been helpful to many, as evidenced by letters we have received, there is, frankly, a selfish motive back of this policy, and that is the assistance these questions give us in determining the type of problems that are confronting engineers today. ¶ In most cases we have or can get the answers to these problems; sometimes, however, several correct answers are possible and when this seems to be the case we like to play the part of a stooge by putting the question to readers and then letting the real actors be guest instructors through the columns of the Practical Engineer and Electrician section of the magazine. So if you are having difficulties of any kind in the operation of your plant, a few lines to the Editor will set information machinery into operation for the purpose of finding a solution to your problem. All the strings are in your hands, just pull one and see what happens.

R. E. T.

A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

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Maintenance vs. Repair

COMMON THINKING among men in power plants does not make much distinction between maintenance and repair. The probable reason for this is because the two functions are so interwoven in the organization that separate specialists have not been developed. Nevertheless the type of mind, the skill and the necessary training for maintenance work is distinctively different from that required by repairmen. And I am of the opinion that many power plants wear out before their time because the men in those plants are required to repair as well as maintain the equipment, in other words, no distinction is made between repairmen and maintenance men and many individuals are required to do both. Let us give a little thought to this idea.

Power plant maintenance is the work necessary to keep the equipment in a physical state as nearly like that in which it was left by the engineers who erected the equipment and started it in operation as the severity of the service will permit. The efficiency of operation should not be allowed to drop. In fact, a well trained maintenance man, who follows the technological advances of the day, in many cases improves the over-all efficiency of equipment under his care as time goes on thus giving him the opportunity to study operating conditions and make needed adjustments.

Maintenance, first of all, is the work of adjusting controls to meet the desired working conditions. These, of course, are not static, and the maintenance man—some would call him the operator—cannot relax his mind from the duty at hand lest some changing condition may throw the whole plant out of balance causing not only a drop in efficiency but even serious damage to equipment. Load, flow, pressure and other conditions subject to variations are, as a rule, specified within limits by the designer of the equipment but it is a maintenance job so to adjust and regulate this machinery as to meet the immediate requirements well within the limits of allowable tolerances.

In these days when automatic control equipment is the vogue in power plants the actual work of valve twisting and rheostat adjustment has been taken over by machinery but the man in charge must now see that the automatics function properly which, in most cases, requires an understanding of fundamental principles far deeper than with manual control. The type of mind required for this class of work is that of a laboratory technician with the responsibilities multiplied a thousandfold.

Another phase of maintenance is the adjustment for wear or the replacement of parts that for some reason no longer perform their functions properly. And here the maintenance man gets into a study of materials that can easily result in lengthening the life of his equipment. In this connection, also, he must be a scrutinizing observer of every condition in that section of the plant under his care. Wear, erosion, corrosion, settling of floors and foundations, deterioration of materials, and many other destructive agencies do their work gradually and over a long period of time in a well designed and operated plant. Some of this, of course, is to be expected but it is only by the exercise of eternal vigilance and the employment of knowledge of functions that expensive and sometimes disastrous breakdowns can be averted by correcting conditions before they become dangerous. In this respect the maintenance man must be a diagnostician capable of recognizing symptoms of distress, such, for example, as excessive heat, incipient leaks, beam or shaft deflections, abrasions, discolorations, character of noise, undesired vibration, unusual dirt or grease accumulations and a thousand and one apparently trifling indicators of undesirable conditions.

Repairs start in when the maintenance man has gone the limit of adjustments and minor replacements. From here on in rehabilitating equipment, i.e., putting it back as nearly as possible into its original condition, the work may truly be called repair and the type of man best fitted to handle this work is an all-around skilled tradesman—machinist, steam fitter, plumber, rigger, brick mason, cement worker, millwright, electrician, welder.

Many operating men in the smaller plants of the country are given duties involving all the functions of maintenance men and repairmen, and they may be handling the work to the satisfaction of the owner, but would the owner really be satisfied if he knew the possibilities of improving the economy, reliability and safety of the plant? It is doubtful. And I believe that engineers for small power plants, that do not maintain a specially trained repair crew, should be selected for their qualifications as maintenance men and that the policy of calling in outside tradesmen to do the major repair work should be adopted instead of requiring men to do all classes of work.

RALPH E. TURNER

A Foreman's Life is Not All Roses

By G. L. Radamaker

MUCH HAS been written in regard to the qualifications of foremen. But these articles have all been written by either an executive in charge of the foremen, or from the point of view of one employed under the foremen. The two viewpoints are as far apart as two ideas could be.

The executive on the one hand too often tries to figure how he can get the foreman to "raw hide" his men to a greater capacity and consequently lower production costs.

The men working under the foremen, visualize the ideal foreman as one who asks them if they are comfortable and bawls the particular devil out of them if they are working too hard.

So as a self-appointed mouthpiece for the foremen, let us see what his problems are that cause premature white hair.

Any foreman is only human. If the big boss comes down on Monday morning after particularly bad luck at poker or little men are dancing around in his head and poking him with red hot pitchforks after his bout with old demon rum, and tells the foreman that if he don't get out so many blankety—blank—blanks he can look for another job and he'll get a foreman who can, it's a cinch that the next underling to meet the foreman is not going to be greeted with a cheery good morning.

Then from the other point of view, the men working under the foremen may come to work feeling under the weather and can't turn out their quota of work. If the foreman now starts to raise particular hell or even if he tries to kid and cajole them into getting out their quota, then to them he is a dirty old so and so who is probably the big bosses brother-in-law.

What does the foreman do, he does just as anyone would do, he bows his head in reverence when the big boss goes on a rampage and then goes out and threatens to fire everyone under him. All for which he becomes an outcast of society, not treated as an equal by his superiors and treated like someone with the plague by those under his jurisdiction.

As stated, it would seem that the foreman's life is not only a troubled one, but an impossible situation which can not be corrected. It is possible for the foreman to better his own conditions himself, but the process is not easy.

Take the politician when the people come storming into his office to make demands. It would be political suicide for him to come out flatly and tell them he could do nothing for them. Instead he talks to them man to man and tries to get them to see where he stands. Irate citizens usually are not satisfied, but are pacified to a certain extent, and if the foreman can get his employer to understand his problem with the workers and get the workers to understand his problem with the employer, the battle is practically won.

For example, if the boss starts one of his tantrums, flies into a rage and feels that he must tell someone off, and it is your tough luck that that someone is you, take it. Then when the eruption has subsided somewhat, explain what can be done and what can not be done and why.

Then after things are ironed out here go back to the men working under you and explain what must be done if you are to hold your job and theirs. It is not necessary to have them pity you, that is the worst thing that could happen, in my opinion, that is to have the people working under a foreman feel sorry for him.

Rather make them feel that your responsibility is their responsibility. It is surprising how willing people are to assume responsibility, it gives them a feeling of importance and satisfies their ego. Benjamin Franklin once said, "If you

want a man to be your friend get him to do a favor for you." If it worked for him I guess it can work for us.

The creation of harmony between the employer and the employees is the problem of the foreman and if his work to this end is successful life for the foreman will be much happier.

Small Valves—The Petty Thieves

By J. C. DeFoe

"PUT IN a new one!" This is one order that is given many times too often to power plant repair men when it has reference to small valves (one inch or smaller). Because the cost of replacing the valve is low compared to most repairs, the order comes much easier and with less consideration than that required for a larger valve. Generally the smaller valves are in lines which can be closed off for a short time without disrupting normal plant operation, hence it becomes a routine repair, to which few give the second thought as to cost. If the small valve repair is necessary in a line which cannot be shut-off without taking major equipment out of service, the importance of getting the equipment back on the line overshadows even the slightest thought of small valve cost.

The satisfactory salvage of small valves after they have been subjected to the average tough power plant service is very low and there's not a small valve manufacturer who wants to increase his sales by seeing small valves he has spent thousands of dollars to develop for the industry, being junked.

Valve manufacturers have, by progressive research, kept in step with modern power plant trends, hence it is reasonable to assume there is a valve designed and fabricated for any power plant service. The valve manufacturers offer and recommend a certain valve for a specific service, beyond that point they have no power to supervise its installation or service.

Study of small valve repair costs certainly should not start at the salvage bench by determining how many valves can profitably be reclaimed for future service. Much can be learned as to what caused a small valve to fail after it has reached the salvage bench, but if you are interested in reducing small valve costs start the investigation in a logical and systematic way.

The first step to insure longer and more satisfactory service of small valves is to obtain from the manufacturer his recommendations for the type of valve to be used in a specific service. Don't keep this information to yourself, post it, and send individual copies to every man responsible for valve installations. The second step is to see that the specified valve is properly installed and packed.

Many small valve failures are due to distorting the valve body by driving the tapered thread too far into the female thread or uneven bolting of the flanges. Long threads, especially on swedges doom many valves to the salvage bench before they are put in service. Jamming the end of a pipe hard against the valve seat wall makes the valve useless for any further service. This happens more often than it is realized, but it leaves its finger prints in the form of a groove on the seat wall. Every screwed valve should be inspected for this cause of failure upon removal.

The third step in reducing small valve costs is to keep a record of every small valve installation and repair. Immediately a protest goes up because a plant may have 777 small valves, to keep a record on each valve would involve too much book work. It's well to remember that sometime in the past the purchase of one valve has reduced the net profit two, five, seven or ten dollars and if it has to be replaced it will do it again. If the valve is short-lived and hasn't given satisfaction it certainly is not desirable to replace it with an identical valve. Also the manufacturer might be in error about his specifications and you have a convincing proof in writing just how the valve performed. Another important point to be kept in valve records is as to whether the valve is operated wide-open or throttled. This has much to do with the life of a small valve. The point is, if you use 777 valves you certainly need a complete record more than one who operates one, three or seven valves.

Small valves (one inch or smaller) are petty thieves, cutting profits just a little bit at a time, unless adapted to the service, properly installed and finger printed.

* * *

A paint remover tool, using 105-120 volt a.c. or d.c., will, it is claimed, remove paint four times faster than a blow torch and without burning or scorching the surface.

* * *

Holes much smaller than a pin-hole can be detected in a yard-wide ribbon of thin sheet steel at speeds up to 1000 ft. per min. by a recently developed inspection machine. A row of phototubes ceaselessly scans the sheet for holes and makes a conspicuous mark in the vicinity of each one that is found. The pin-hole detector can be used for other materials, including rubber-coated cloth.

Photo courtesy Westinghouse

Noisy Gears Out-moded

It is no longer fashionable to have gears that screech or moan while they are doing their work. The fact is, nobody ever likes that kind of music and everybody is happy to employ the silent workman, but it has taken a long time to find helpers with this qualification.

When the gear and pinion teeth of a drive such as used on a street car mesh, the striking of steel against steel makes a loud sound, which the vibration multiplies and holds for several seconds. With the gear turning over rapidly, a new blow is struck as each tooth meshes, keeping up a steady din.

By putting a thin band of steel into the inside rim, welded at only three or four points, the vibration caused by each stroke of the teeth is taken up by the thin band, and the resonance or noise is "damped" out. The ring must be welded to the gear at just the right number of places, neither too few nor too many, else the vibration will not be damped by the ring, or the ring will react equally with the gear.

The two standard bull gears shown mounted on a table with a steel mallet swinging between are exactly alike, except that one has a steel ring welded loosely around the rim of the gear to keep it from vibrating at its natural frequency and are used to demonstrate the difference in resonance between the two gears by striking with the hammer. Only a dull "clink" is heard from a blow on the gear with imbedded ring; a resonant "clang" of seconds duration results from a stroke on the other gear.

POWER FUEL PRACTICE

Chain Grate Stoker Operation

By A. Bement

EXPERIENCE has demonstrated that a fire thickness at the entrance gate of natural draft chain grate stokers of 7 or 7.5 in. gives best efficiency as well as good capacity. In fact, in the use of 2-in. screenings even a thicker fire may be desirable.

Best operating performance with natural draft chain grate stokers has been, in important measure, developed by electric power companies which have given the matter special study. Considering the source of such practice, it could be assumed that in general such fuel bed thickness would be the prevailing practice. More generally, however, this has not been true. Observation has disclosed that fuel bed thickness of 5 in. and less, even down to 3.5 in. prevails.

A study of the situation has indicated that this disagreement in practice has not been due to difference in opinion but rather to physical characteristics of the equipment.

The essence of the matter is one of stoker speed or travel. In the great majority of cases observed, the chain is driven too fast, while all such stokers are provided with adjustment, by means of a ratchet arm for example, if the driving motor, engine or shaft be operated at abnormal speed, range of adjustment at the ratchet arm may not be sufficient to overcome the effect of this excessive speed.

If a thick fire prevails with excessive speed of chain, it follows that more coal may be fed than can be burned, with the result that live fire is discharged over the back end of the grate. When such situation exists, the remedy is to reduce the rate of travel of the chain and so correct the feed of coal. If however, the rate of feed of coal cannot be controlled by stoker speed reduction, the only available remedy is to cut down fire thickness to a point at which fire will finish at the end of the grate, if possible.

Observation has shown many cases of abnormal fire condition of this character which may be best illustrated by certain cases. In a flour mill, the chain grate stoker was driven from a shaft which conveyed power to other equipment which governed speed requirements, the adjustment at the ratchet arm was at the limit of slow travel. A thick fuel bed prevailed and a very serious loss occurred due to fire discharged over the end of the grate. A rather thick fuel bed was carried because boiler load conditions demanded it. It would have been to the advantage of economy of combustion to have carried a thicker fuel bed but to do so would have caused increased loss over the end of the grate, not only enlarging the loss of fuel wasted to the ash pit but offset the gain of more efficient combustion. The remedy was to secure the proper driving speed so that the adjustment at the stoker would cover travel requirements of the chain.

An extreme case was an electric power station equipped with 15 boilers of 700 rated hp. each and five others of smaller size. Very good coal was used. At times a load of 5000 kw. was a practical limit, and 7000 kw. was considered a maximum achievement. The stokers were driven by a fixed speed electric motor and speed delivered to the chain grates was greatly in excess of what it should have been. With adjustment at stoker arm at minimum travel and a 3.5 in. fuel bed about one third of the fire went over the back of the grate into the ash and refuse bunkers. At the same time the entering coal did not ignite until it had entered the furnace about a foot or so. In an effort to reduce the excessive loss of the fuel over the end of the grate, less coal was fed to the stokers. This produced the thin fires, delayed ignition and caused low boiler capacity. The remedy was to correct the speed of the drive to the stokers.

The best chain grate operating practice was developed at the old Harrison Street electric power house in Chicago. Here the driving power was furnished by small steam engines, one on each side of the firing aisle and on the firing floor directly accessible to the boiler house foreman and to the stoker operators as well. Their problem was to carry a 7.5 in. fire with full draft and to limit the end of the fire at the end of the grate. If adjustment at stoker arm did not suffice, engine speed was adjusted by increasing or decreasing steam supply to it by hand throttle.

This matter of chain grate speed is rather far reaching. In Illinois especially, there is available valuable chain grate fuel in the form of small prepared coal, such as No. 2 nut, 2 by 1¼ and chestnut, 1¼ by ¾ in. These sizes should be used extensively but so far, for chain grates, have not been received favorably and the reason is inability to control stoker speed or failure to realize the necessity for doing so. These sizes demand a very thick fuel bed, even up to 12 in., but they must be fed very slowly. This fuel has the advantage of large capacity, high efficiency and freedom from "sifting" or falling through the grate, as occurs with screenings.

While No. 2 nut and chestnut have met favorable reception for other forms of stokers, they have not done so with chain grates for reasons explained in the foregoing. Thus far only the pea size ¾ by ½ in. has had extended use for chain grates for the reason that this fuel in a measure fits into practice prevailing with screenings. Pea coal, however, is not free from sifting through the grate.

The foregoing discussion pertains specifically to natural draft chain grate stoker practice, but in certain respects applies to forced draft chain grate stoker operation as well.

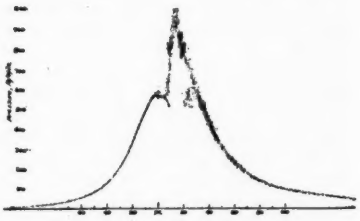
Fuel Dopes and Alcohol Mixtures

SEVERAL FUEL OILS, fuel dopes and mixtures of alcohol and fuel oil were tested in a high speed, single cylinder, compression-ignition engine to determine the power output, the fuel consumption and ignition and combustion characteristics. The reports of these tests were made in N.A.C.A. T.N. No. 707 by Chas. S. Moore and Hanson H. Foster.

Oils, doped or undoped, of high cetane number had shorter ignition lags, lower rates of pressure rise and give smoother engine operation than oils of low cetane number. Higher engine rotative speeds and boost pressures resulted in smoother engine operation and permitted the use of fuel oils of relatively low cetane number.

Although the addition of a dope to a fuel oil decreased the ignition lag and the rate of pressure rise, the resulting rate of combustion was somewhat slower than for the undoped fuel oil so that the effectiveness of combustion was practically unchanged.

Alcohol used as an auxiliary fuel, either as a mixture or by separate injection, increased the rate of pressure rise and induced roughness. In general the power output decreased as the proportion of alcohol increased and the below maximum power varied with the heating value of the total fuel change. This was especially true with more than 25 per cent alcohol.



With 40 per cent alcohol ignition lag was decreased as much as 88 per cent and with 80 per cent alcohol, the fuel could not be ignited at a compression ratio of 14.5. The spontaneous ignition of fuel oil is around 500 deg. F. and that of alcohol over 1000 deg. F. The corresponding heating values are about 19,900 and 11,700 B.t.u. per lb. respectively. The indicator card reproduced is for a mixture of fuel oil and 40 per cent alcohol. The ignition lag was 16 deg. and the pressure rise 97 lb. per deg. This compares with 8.5 deg. and 43 lb. for the fuel oil alone; 6.5 deg. and 28 lb. for the same oil plus 4 per cent tetranitromethane; and 11.5 deg. and 70 lb. for a No. 3 furnace oil. In the above card the first peak is about 560 lb. per sq. in. and the second about 1000 lb.

WATER FOR POWER PLANTS

Boiler Water

SEVERAL PAPERS on various problems relating to water for industrial uses were presented at the A.S.T.M. annual meeting in a session devoted entirely to this subject. The Report of Committee D-19 on Water for Industrial Uses and the Report of the Joint Research Committee on Boiler Feedwater Studies were given and five technical papers were included. Messrs. Corey and Finnegan, Consolidated Edison Co., described a study made of the reaction between iron and water at room temperature in order to obtain experimental information regarding the fundamental corrosion reaction. The work was conducted in iron vessels, and the water which was used was free of dissolved oxygen and carbon dioxide. This procedure eliminated these gases as factors and also insured the absence of impurities that might be introduced by contact with glass vessels.

It was found that the solution reached a pH value of approximately 8.3 and contained about 0.2 p.p.m. of dissolved iron. The solid product of the reaction is predominantly Fe_3O_4. Previous investigators have reported pH values of the order of 9.0 to 9.6, but it is believed that the use of glass vessels was responsible for higher results than those reported here. In their conclusion they mentioned that one may conceive of an oxidation process in which the initially formed ferrous hydroxide decomposes the water to form magnetite as the final solid product.

R. C. Ulmer of the Detroit Edison Co. in his paper on Determination by the Evaporation Method of Small Amounts of Dissolved Solids in Water Such as Condensed Steam From Boilers indicated that, essentially, the method used consists of evaporating a 5 gal. sample of condensed steam in a weighed platinum dish under conditions which attempt to minimize the possibility of contamination of the sample and residue. The results obtained in this investigation indicate that accurate determinations of steam purity can be obtained by the evaporation method in from 5 to 7 days. During this period, only a few minutes supervision is required once each day. In case more than 0.5 p.p.m. of solids is present in the steam, a smaller sample may be evaporated, thus proportionately decreasing the time required to obtain results.

Speeding Up Water Analysis

By S. H. Coleman

DURING RECENT YEARS power plant management has realized that no system of boiler water conditioning can be expected to function properly without some means of checking and control. Such supervision requires that water samples taken from the boilers and various points in the feedwater system be frequently analyzed. In order to make these routine determinations, the engineer, already a jack of all trades, has had to grasp the rudimentory mechanics of the chemists' profession. While this knowledge is easily acquired even though the engineer has had little or no previous training in chemistry, considerable time is needed to make these analyses, especially where the plant has a number of boilers. Here are a number of wrinkles that will reduce the time required.

Filtering

Filtering the sample usually takes more time than is required to make the analysis. This process can be speeded up in a number of ways. Among these are: Always filter the sample while it is still warm; use a funnel having fluted sides rather than one having smooth sides. If such a funnel is not available, the filter paper can be folded a number of times, reversing alternate folds, so that when

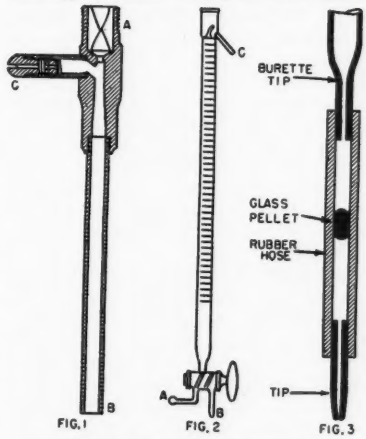


Fig. 1. Filter suction pumps
Fig. 2. Self leveling burettes
Fig. 3. Glass pellet

it is opened and inserted in a smooth funnel it is pleated. Fluted funnels or pleating the filter paper prevents the paper adhering to the flat surface of the glass and allows free flow down into the neck of the funnel.

A vacuum created in the neck of the funnel by a filter suction pump Fig. 1 will also speed up the filtering process. These pumps are simple aspirators utilizing the velocity of water entering through the threaded connection A and exhausting to waste at B to create a suction at C. The flask or other receiver for the filtered sample is equipped with a two hole rubber stopper. The funnel is placed in one hole and a short piece of glass tubing in the other. This tubing is then connected to the suction pump with rubber laboratory hose. With a little practice the optimum vacuum can be obtained merely by increasing or decreasing the flow of water in the pump.

Titrating

Titration can be greatly simplified and the possibility of errors when subtracting burette readings eliminated if self leveling burettes Fig. 2 are used. These burettes are designed so that when full the liquid comes to rest exactly on the zero mark. Any excess solution overflows into a receiving bottle connected with a rubber hose to opening C. The burette is filled from an overhead storage bottle connected with tubing to opening A. A two way stop cock is arranged so that when the burette is full reversing the cock shuts off the flow from the storage bottle and allows the liquid to flow into the tip connection B. The burettes can also be obtained without the stop cock. With this type it is necessary to use pinch cocks on the filling and tip tubing.

Burette tips equipped with pinch cocks are very unsatisfactory when titrating samples as it is almost impossible to accurately control the drops required when the end-point is approached. A glass pellet, made from a piece of stirring rod and inserted in the rubber tube of the tip, Fig. 3, is much more reliable. Normally the pellet completely closes the tube but when the rubber is squeezed with the fingers it is distorted and allows the liquid to flow between the pellet and the inner wall of the tube. By adjusting finger pressure, remarkably accurate flow control can be obtained.

Cleaning

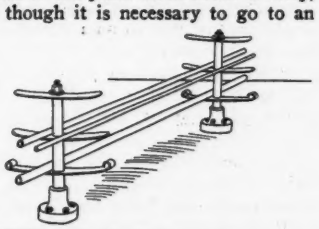
When the glass and porcelain laboratory ware used in making water analyses becomes dirty or stained, ordinary methods of cleaning are usually worse than useless. A cleaning solution made by dissolving potassium chromate in commercial sulphuric acid will, however, remove most of these deposits. Enough potassium chromate must be added to the acid to make a saturated solution, a point that can be determined by noticing when a residuum of crystals is seen in the container.

The solution is poured into the dirty vessel, allowed to remain for a while, and then poured back into its original container. In this way, it can be used over and over again until it becomes weakened, then a fresh supply is needed. As the cleaner is a very strong oxidizing agent the utmost care must be used to prevent it getting on the clothes or person.

Pipe Stand

By Chas. H. Willey

HERE is a good use for the leaves of an old truck spring which can be easily adapted to the plant stock room or shop, even though it is necessary to go to an



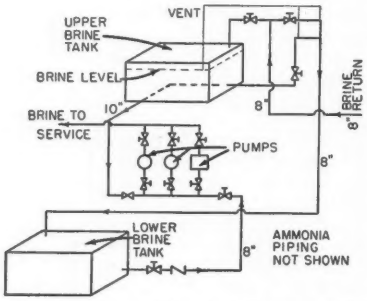
auto junk yard and give a few cents for the material. The construction is shown quite plainly and all the pipe flanges and spacers should be available about the plant.

REFRIGERATING PRACTICE

Operating Brine Tanks in Parallel

By Anthony A. Fette
Chief Engineer
Burger Brewing Co.
Cincinnati, Ohio

TO TAKE CARE of expansion and allow greater flexibility, we recently added a new brine tank. The only space available was below the present brine tank. This location was questioned at first because the brine pumps were on the level with the old tank where they have a positive head on the suction. There was some question as to whether they would operate satisfactorily with a suction net lift of 10 ft. This, however, was but a minor problem at the time and later developments proved it to be unimportant. The brine pumps are two 1750 r.p.m. centrifugals and one duplex steam type and no difficulty has been experienced during several months of operation.



Connections for brine tanks operated in parallel

We have, however, had difficulty with the control of these two tanks in series and had to do considerable experimenting to arrive at a satisfactory solution. In the upper tank the brine is cooled by direct expansion, controlled by a king valve at the ammonia receiver. The lower, or new, tank has a flooded system with the ammonia level in the accumulator regulated by a float valve. The plan of operation is to return the brine to the upper tank where it is partially cooled and then overflows to the bottom tank. The cooling is finished here and the brine is then pumped into the system from the bottom tank and returned to the top tank. The piping arrangement, however, is very flexible so that we can pump from either tank in emergency.

With the upper tank only in operation, the brine is discharged into the top at the west end. A 10-in. suction pipe comes in at the lower east corner and extends nearly across the tank with a series of 2-in. holes drilled into the pipe so as to get even brine travel and good distribution.

When it was decided to operate the two tanks in parallel, it was decided to retain circulation advantages of the old 10-in. suction pipe, therefore this suction pipe was elbowed around the southeast corner, extended parallel with the south wall and brought out of the tank through the lower west end. It was welded to the tank and then carried up on the outside of the tank to the brine level where by means of two right angle bends the overflow line with an 8-in. valve was turned 180 deg. and extended down to the lower tank.

In order to prevent siphoning, one of the upper ells was tapped for a ¾-in. pipe connection to admit air and break the siphon. This ¾-in. hole proved to be inadequate and the lower tank had a tendency to overflow. Tapping the second ell for a ¾-in. vent did not improve matters greatly. Both openings were then enlarged to 1½-in. and worked considerably better.

With these two 1½-in. openings, however, we were drawing considerable hot air from the engine room into the cold brine. To prevent this the two 1½-in. pipes were connected to a 2-in. tee and extended to the top of the lower brine tank so as to draw in cold air.

For a while this worked satisfactorily but trouble developed again suddenly and we found that both nipples in the overflow ell were choked with salt. These ells were replaced with tees and once a week we remove the plugs and rod the nipples so as to remove the accumulation of salt.

Completely satisfactory operation was not obtained, however, until after we had followed the suggestion of my son, George, to extend the 2-in. pipe farther into the brine tank and turn it down until it reached the desired brine level. This is shown in the detailed drawing.

Now when the brine rises the vent is automatically sealed and the brine is piped through the 8-in. overflow pipe and of course also through the 2-in. vent pipe. When the brine level drops below the desired point, however, the end of the 2-in. vent pipe is immediately uncovered and breaks the vacuum. Since this arrangement has been in use we have had no trouble and the system works to perfection.

Ammonia Leaks in Brine

WHEN ammonia leaks into brine or the location of the leak is submerged and cannot be detected because the escaping ammonia goes into solution with the water or the brine, the liquid should be tested with a suitable reagent. Litmus paper is fairly reliable, although a more satisfactory method is to add a few drops of Nessler's solution to a sample of water or brine. It will turn slightly yellow when traces of ammonia are present. When large quantities are present a reddish brown precipitate will be found. Calcium brine should be treated with sodium bicarbonate before the solution is added.

Nessler's Solution can be purchased already made-up or it may be made as follows: dissolve 17 gr. of mercuric chloride in 300 cc. of distilled water and then 35 gr. of potassium iodide in 100 cc. of distilled water. Add some of the first solution to the last, stirring constantly until a slight permanent red precipitate is formed. Dissolve 120 gr. of potassium hydrate in 200 cc. of water, allow to cool then add to the potassium iodide solution with sufficient water to make one liter. Add more mercuric chloride solution until a permanent precipitate again forms. Allow to stand until settled and decant the clear solution for use. Put in a glass stoppered blue bottle and keep in a dark place.

Refrigeration Plant Lubrication

By A. G. Solomon

PRESENCE of oil in the system has been a problem for the engineer ever since the compression type of refrigeration has been in use. Since the coming of the enclosed type compressor the oil has become more troublesome in many cases due to the pumping from the crank case. All the oil that causes trouble throughout the system must come from the crank case where it is put for lubrication of the moving parts.

It is hard to account for the oil leaving the crank case unless all the facts of machine design, arrangement of piping and methods of operation are known. The most common cause of oil pumping is found in the fit and condition of the piston rings and cylinder walls. Scored cylinders or improper piston ring contact with the cylinder walls will allow oil to pass from the crank case to the space above the piston and then through the discharge valves and into the condenser, liquid receiver and evaporating coils.

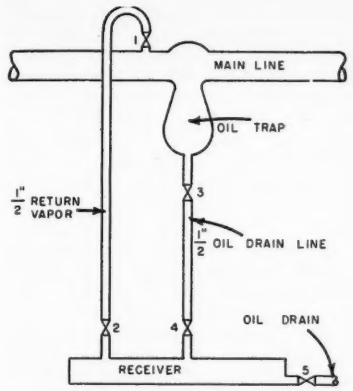
Very little oil that circulates in the system returns to the crank case. Most of it that comes through the main suction line finds less resistance at the compressor suction valves than it does at the oil rings found on the lower part of the piston.

If the spring tension of the suction valves is any greater than is absolutely necessary, the downward stroke of the piston will lower the pressure in the cylinder below the pressure in the crank case. This spring tension has been found to be the cause of excessive oil pumping. A compressor operated at a higher rate of speed than it was designed for will also cause oil pumping.

Open up the compressor and remove the pistons. Examine the cylinder walls for cuts and wear. Rebore if necessary. Examine the piston for neatness of fit in the cylinder. Examine all the piston rings for wear, fit in the cylinder, fit in the piston ring grooves and space at ring ends. Be sure that ring joints are staggered.

Next check tension of suction valve springs and allow just enough to balance the valve. Look at the cage or other arrangement that holds the suction valve in its place in the piston. Leakage between the case and the piston will cause oil pumping.

It is sometimes found that a compressor will pump excessive oil when



operated with a low suction pressure as when working on low temperatures. Use the lightest suction valve possible and as little spring tension as practical.

Do not carry a higher oil level in the crank case than is needed for proper lubrication. If the compressor is equipped with the force feed or pump system of lubrication the cause of the oil leaving the crank case may be found in the oil piping itself. The wrist pins that connect the top end of the connecting rod to the piston require very little oil. If a large amount is being sent to the wrist pins, cap the end of the oil pipe and drill a small hole in the cap. By having a lot of oil sprayed up into the lower part of the piston the amount of oil vapor is greatly increased and the oil leakage past the lower rings is greater. Carrying a higher oil pressure than necessary may also cause oil loss.

Next to consider is the removal of oil. There are very few installations that are not provided with an oil trap on the discharge line. If these traps are not in at present they should be put in at the first opportunity.

The trap on the discharge line should be located as far as possible from the compressor so as to give the fine particles of heated oil a chance to cool and collect so that the trap will be efficient. Often the oil is so heated and atomized that the oil trap is useless.

The suction trap can be at any place along the main suction line. Both discharge and suction traps should be drained at regular intervals. As it is not a pleasant job to drain oil traps and often a lot of ammonia is lost it will be found to be a great help if a small receiver is placed below each trap. Make two receivers large enough to hold as much oil as will be drained from the traps during a week's steady operation. These receivers can be made out of pipe with ends welded in. Also have the needed nipples welded. Place the receivers in the warmest place convenient so as to help separate the ammonia from the oil.

This is drawn for a suction line trap but the discharge trap and receiver is the same except that the return vapor line is not needed. In operation valves 1, 2, 3 and 4 are kept wide open and closed only for inspection, repair or draining. Valve 5 is to drain the oil from the receiver which should be allowed to fill sufficiently so there will be very little ammonia in the oil.

The sketch will show the connections to the receiver.

When there is no oil in the suction trap receiver the receiver will be frosted if the saturated ammonia is carried that far in the suction line. As the receiver collects oil the frost will leave. After some close observation and practice the oil can be drained with very little loss of ammonia.

The time of emptying these receivers will depend on the amount of oil that they hold. It need not be done daily unless the system is very badly loaded with oil. Receivers of the same kind can be installed to good advantage at low points of the system.

By finding the cause of the oil pumping and applying the proper remedy, and then paying close attention to oil removal the excess oil can be drawn out of the system at little expense and not much added to labor. Keep a close record of the amount of oil put in the crank case and also of the amount of oil drained out. This oil can be filtered and used over again.

Some engineers make a practice of cleaning all evaporating coils yearly or at intervals of 2 to 5 yr. This internal cleaning is done by blowing out with steam and air. If such a cleaning has to be done it must be done by an experienced man or moisture trouble will follow. And moisture in a system is much worse than oil.

If there is a screen in the suction line it must be cleaned at regular intervals to prevent pressure drop.

FOR THE PLANT ELECTRICIAN

Converting Resistance Units From the Metric System

By Eugene George Key

TWO GENERAL systems are used in the United States for determining the units of resistance of electrical conductors. The one commonly used by wiremen gives the resistance in "ohms per mil foot." The unit is a circular conductor one mil in diameter and one foot long, a mil being one thousandth of an inch. The second is the metric unit of "microhms per cubic centimeter" or millionths of an ohm in a conductor one cubic centimeter in size.

Many reference books give both of these systems, but, unfortunately, a few give only one. It is sometimes convenient, then, to know how to convert one of these systems into the other if the table at hand gives the values in the wrong units.

The formula for resistance is as follows:

$$R = p\frac{l}{A} \qquad (1)$$

where R is the total resistance, p the resistance per unit (called "resistivity"), l the length in feet or centimeters, and A the area in circular mils or square centimeters. p, then, is:

$$p = \frac{AR}{l} \qquad (2)$$

R and l, of course, are variable quantities, but p, when being changed from the metric system to the resistance per mil foot, is equal to:

$$p = \frac{R(2.54)(12)(10^6)}{1(2.54)^2(0.7854)} \qquad (3)$$

where 2.54 is the conversion factor from inches to centimeters, 10^6 the number which raises microhms (10^{-6} or millionths of an ohm) to ohms, and 0.7854 the constant which converts the circular unit to the same unit in a square.

By performing the operation indicated in (3), we obtain:

$$p = \frac{R}{l}(6.015)(10^6)) \qquad (4)$$

This factor, 6.015 (it may be used more conveniently as 6.02) is the numerical constant which, multiplied by the numerical value of the metric unit, gives the resistance in ohms per mil foot. The following table illustrates how accurate calculations using this constant may be. Column 2 gives the metric unit in ohms, column 3 gives the common unit in ohms, and column 4 shows the values obtained by multiplying the values in column 2 by 6.02×10^6. Column 4 should equal column 3 within one-fourth of one percent:

conductor	metric unit	common unit	col. 1 × 6.02 × 10^6
copper	1.72×10^{-6}	10.37	10.34
aluminum	3.21×10^{-6}	19.3	19.3
zinc	6.1×10^{-6}	36.7	36.7
Nichrome	110×10^{-6}	660	662

On Welding

EDITOR'S NOTE: *The following letter was recently found in the mail with no identification. It may be from an individual—it may be from a manufacturer—it may be sincere—it may have an axe to grind. There is, however, a great deal of common sense in what is said, sufficient we believe to warrant its use.*

* * * *

ARC WELDING has too many doctors. An operation which is perfectly natural, very simple and very easily accomplished, has largely been changed in the minds of the public to an art which takes on the mystery of voodooism with an admixture of the art of the medicine man.

The public is beginning to think that the welding operator is a cross between a miracle man and a professional musician. This opinion is groundless. The only thing that a welding operator can do is to hold the end of an electrode at a certain distance above the deposited metal and advance it along the seam to be welded at a certain speed. There is nothing more that is involved in this operation. It is neither complicated nor difficult. As a matter of fact, with proper electrode, proper setting of the welding machine and proper preparation of the work, it is practically impossible to make a weld which will not stand up in service without having it so evident to the inspector that he would immediately reject it. It is possible to have defects in the steel that cannot be seen which will make a steel structure dangerous. It is impossible, however, to make a weld on that structure which is dangerous without it being obvious to anyone looking at the weld.

The reason we hear so much about the necessity of skill and care in welding is largely due to the fact that the operation itself is so simple that it is difficult to find much about it to discuss in papers, lectures and statements. Therefore, many of these eccentricities which are volubly discussed in magazine articles, lectures and statements, consist of theoretical possibilities which exist only in the minds of the lecturers and seldom exist in reality.

It is time that we got away from trying to make this very simple operation mysterious. It is time that we recognize the fact that the metal deposited by the shielded arc electrode is definitely better than the parent metal it is joining. It is time we recognize that there has never been a failure on an insured pressure vessel made by the shielded arc process. It is time we recognize that in the usual design if only half a weld is made it will withstand all of the normal requirements of the structure. It is time we recognize that failures in welds which are made by the methods recommended by any reliable manufacturer never exist. It is time we recognize that there is no mystery in welding and that making a welded joint is far more simple than making a riveted joint and more simple than making the steel which is joined together by this process. It is time we recognize that to spend time, money and attention in removing the least possible flaw from the deposited metal is silly in the light of the obvious flaws which must occur in the parent metal. A factor of safety is used to guard against these flaws. That is more than is needed in any commercial weld.

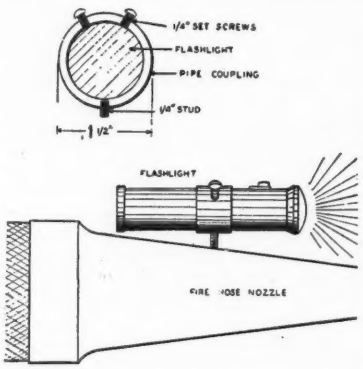
When we do recognize these facts we will have done two things: first, we will have given the green light to one of the most economical processes now known for the production of many structures; secondly, we will have removed one of the fears which the uninitiated have developed regarding a perfectly normal manufacturing operation.

Welding Economy

A two weeks shut down of the school at Seton Hall, West Orange, N. J., was forestalled by arc welding. A leak in the hot water boilers was repaired by stripping the insulation and welding on a 6 by 24 in. lap joint patch. The welder from the McCabe Boiler Corp. of Newark, N. J., is using a Westinghouse 400 amp. portable motor-generator set.

Handy Light

DUE to the inconvenience and danger an extension light is not advisable when washing boilers. A light is, however, almost a necessity so one enterprising



engineer rigged up the flash light arrangement shown in the cut. The flashlight fits nicely in the 1½ in. pipe coupling and the set screws hold it in place firmly. It gives plenty of light where needed and leaves both hands free.

Motor Got Hot

By Charles W. Parks

OUR AIR compressor motor ran hot, and had been doing so ever since it was installed. We were originally operating a small compressor, but this soon was far too small for our needs, so we bought and installed a larger one and kept the one we had in reserve. We had a 3-hp. motor in stock that fitted the requirements of the new machine, so we used it. The motor ran hot, so hot that you could not hold your hand on it. We called the air compressor company that installed the compressor to find the trouble. They said the motor was old and needed cleaning. We cleaned the motor and the results were the same. We called our electrical company. They said the motor was too small for the load. So we ran on. The motor only got so hot and no more.

Finally we moved the compressors to a more convenient place in the boiler room. I cleaned the compressors from A to Z and found our long hunted for trouble. The air compressor was attached to a base which was mounted on the air receiver. The discharge pipe from the big compressor is ¾ in. on each cylinder head (being two pistons under each head) and where they joined into a 1-in. copper tubing, which ran around and down into the tank, they were bushed to ½ in. Here was the trouble.

Oil Specifications vs. Try-outs

By W. F. Schaphorst

LUBRICATING oil specifications that would satisfactorily meet all requirements have never come to my attention. The essential properties of a lubricant defy perfect description in the same way that so many common things with which we come in contact cannot be defined. Might as well try to specify a perfect lady. It can't be done.

Specifications do not specify lubricity. Lubricity is the essential property of any lubricant.

Years ago I attended a lecture in which a college professor told us that the best way in which to specify an oil was first to find the oil that was satisfactory in every way and then analyze that oil. He stated that any oil which would show the same analysis would have the same viscosity, flash, gravity, cold test, etc., should be as satisfactory a lubricant as the original.

I have learned since, however, that the professor was considerably "off." No reliable test for lubricity has ever been discovered other than the actual use of the oil on the bearing it is to lubricate. It is a well known fact that high grade oils have a greater lubricating value than others. This is proven by the fact that bearing temperatures, when high grade oils are in use, will not run as high as they do with low grade oils. Yet the specifications of the two grades of oil may be identical in every way. Although the consumer orders oil, what he really wants is lubricity; and none of the specifications include this property.

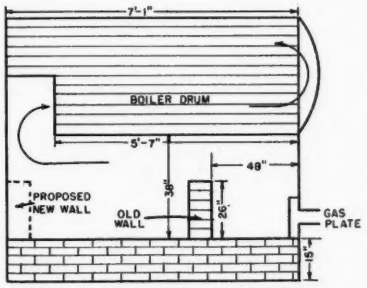
Imitators are so clever these days that it behooves us to be exceedingly careful. The best oil specification, I claim, is to deal with reliable concerns. Pigeonhole your color, gravity, viscosity, and other specifications. Find the "brand" that does the work and then stick to it.

Questions And Answers

Would Change be Improvement?

I HAVE two low pressure boilers, h.f.t. 40 in. drum with 7 ft. 1 in. top tubes and 5 ft. 7 in. lower tubes, all 4 in. in diameter. Total number of tubes 51.

Each boiler sets 15 in. off the floor and has a height from fire box floor to the drum of 38 in. The width above the brick work on the sides is 32 in. The brick work comes up 16 in. from the floor. Four feet back from the fire door is a bridge wall 26 in. high. These boilers are gas fired, fed from 1¼ in. gas line into a 9-hole distributing plate. The center of gas plate is 32 in. below the drum.



Change proposed in gas-fired furnace

I am considering taking this wall out and moving it against the back wall. This would give me an open fire box the length of the boiler. As it is, the flame hits this wall and travels up and along the drum. I would greatly appreciate the advice of readers on this change.

Los Angeles, Calif. E. G. D.

Coal Purchasing Contracts

IN THE July, 1940, issue of POWER PLANT ENGINEERING, under the topic of "Questions and Answers," we noticed the section devoted to "Coal Purchasing Contracts."

Since we have had a great amount of experience in the use and application of such contracts and are serving numerous clients in this respect, we wish to reply to W. C. W. and set forth our ideas on buying coal under contract specifications.

Indeed, it is practical to purchase coal on a specification basis for several reasons. One reason, and probably the most important, is to determine, by means of a formula, the quality of the coal as delivered as compared to the guaranteed quality as set forth in the original contract. By means of the Net B.t.u. for 1c formula and the Delivered Value formula, both of which are explained below, it is possible to determine from an analysis of the coal in question the value in dollars and cents, as compared with the guaranteed price and quality as stipulated in the contract. The thought behind this method of coal purchasing is that payment should be made only on value of goods received.

Another reason for buying coal on specifications is due to the fact that coal itself is a heterogeneous material, and consequently is subject to variation. This variation has its effects on plant performance, and therefore should be subject to some method of control, just as much as a piece of machinery is subject to plus and minus tolerance limits.

If a penalty clause is provided in the contract, it is our opinion that the moisture, ash, and heat contents should be included. At least one reason for including the moisture content is to determine what part it plays in the amount of coal to be paid for. Water is cheap, and if there is an excess of moisture to be paid for at the price of coal, this obviously increases the cost of plant operation, to say nothing of the additional heat required to evaporate this moisture and superheat the resulting steam to stack temperatures.

Coal containing an excess amount of ash gives off less heat. The increased problem of handling and maintenance is another factor.

The heating value, or B.t.u., contained in the coal is the most important constituent to be considered and should therefore be covered by the penalty clause of a coal contract.

A contract to be legal must contain equity; that is, if a penalty is to be provided for failure to meet the specifications as set forth in a contract, a bonus must also be provided if contract specifications are exceeded.

We have been called upon numerous times to evaluate bids received by boards of education, municipalities, real estate concerns, etc. Our method of determining the low bid is to tabulate the bids received and reduce them to one figure, the Net B.t.u. for 1c. In this manner, the bidder who guarantees the highest Net B.t.u. for 1c is considered the low bidder, taking into consideration adaptability of plant equipment to properly burn the coal, size and preparation of the coal, etc. Our formula for calculating the Net B.t.u. for 1c is as follows:

$$C = \frac{2000\,H}{P + A_d}$$

Where: C = Net B.t.u. for 1c.
H = B.t.u., "as received" basis.
P = Price per ton of coal expressed in cents.
A_d = Ash, per cent dry basis, expressed as a percentage.

You will notice in the above formula that all of the ash content is considered; whereas W. C. W. takes only 0.5 of the ash. We believe a greater penalty than 0.5 should be applied to the ash, due to the costs of handling, maintenance, and effect on plant performance.

Our formula for determining the Delivered Value of a coal received, expressed in dollars and cents, as compared with the original contract guarantee, is as follows:

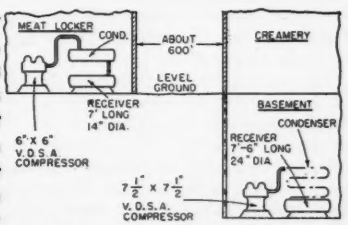
$$V = \frac{2000\,H}{C} - A_d$$

Where: V = Delivered Value expressed in dollars and cents.
H = B.t.u., "as received" basis.
C = Net B.t.u. for 1c as guaranteed in contract.
A_d = Ash, per cent dry basis, expressed as a percentage.

It is our usual practice to allow a tolerance of plus and minus 2 per cent of the Net B.t.u. for 1c determined on the coal as delivered, before any bonus or penalty may be applied.

With reference to the question of who is to pay for the sampling and analysis work in connection with a coal contract specification, this is borne by the consumer as a rule. This charge is nominal, and is generally a very small percentage of the cost of the coal involved; this

Out west, L. S. has a meat locker plant and a creamery about 600 ft. apart. The receiver in the creamery is only large enough for the coolers there. He would like to inter-connect the two so that compressor in the creamery could be used on the meat locker in case of a breakdown of the latter compressor. He wants to know the best way of making the connection. Should he run a suction and discharge gas line over to the creamery compressor and continue to use the meat locker condenser and receiver, or would it be best to use a suction gas line and small liquid ammonia line and use the creamery condenser as well as the compressor?



very fact making attractive the specification method of coal purchasing as a safeguard for obtaining the quality contracted for, and by an equitable method penalizing or giving a bonus when the occasion arises.

R. W. LANGTRY,
Secretary.
Commercial Testing & Engineering Co.
Chicago, Ill.

Luminous Flame Firing

REGARDING the inquiry by P.J.F. about "Luminous Flame Firing," and the reply given by R. C. Vroom, Chief Engineer of Peabody Engineering Corp., New York City, in the May 1940 issue of Power Plant Engineering, we take issue with several points brought out by Mr. Vroom and these points are as follows:

For one thing the statement is made that . . . "when you get a luminous gas flame, you also get a lower flame temperature" . . . From the point of view of heat transfer we are generally more concerned with the "furnace temperature" and less concerned with what the "flame temperature" at a given spot of the furnace would be. We believe it is worth pointing out that the only difference between the gas flame and the oil or luminous flame is that the gas flame is a more concentrated flame. In other words the B.t.u. release per cubic foot of gas flame is comparatively higher than that from the luminous flame. The furnace temperature, however, would be the same irrespective of whether the non-luminous or the luminous flame were used.

Mr. Vroom then puts considerable emphasis on the thesis that . . . "the rate of heat transfer from the hot surface of the heat absorbing surface is a function of the fourth power of the difference in temperature between the radiating body and the heat absorbing body," . . . but he fails to give even an inkling of how much of a difference in temperature there would be. On the other hand the emissivity of the luminous flame which is a factor of greatest value in heat transfer, is passed over as though it were of no consequence.

By using a luminous flame in the installation of an industrial forge furnace the writer was able to increase the output of this furnace by 25 per cent. This achievement tends to prove that the higher flame temperature is relatively unimportant and that the emissivity of the luminous flame is significant. Mr. Vroom, by way of contrast, gives a great deal of attention to flame temperature and very little to emissivity.

The point is also made by Mr. Vroom that luminous flame is used in metallurgical furnaces where high flame temperature is not desirable. He overlooks entirely, however, that the greatest application of luminous flame is to the industrial furnaces in connection with which more burners have been changed to luminous flame than in any other field. And the reason for the noticeable change over to the luminous flame in the industrial furnace field is primarily to take advantage of the increased output of the furnace which results.

In connection with P.J.F.'s inquiry about "whether it is practical to carry a luminous flame" and whether any of the boiler rating will be lost we can say that the effect of a luminous flame on a boiler is not as high as on an industrial furnace. If, however, the inquirer has the proper combustion space and a properly designed installation he will definitely get more capacity with the luminous flame than could be had from the non-luminous flame because more heat will be absorbed from the luminous flame as radiant heat.

Chicago, Ill. ZUCE KOGAN

Water Heater Connections

AFTER LOOKING over W.A.D.'s problem (p. 76 March) I cannot understand why an engineer would hook up the return on a hot water boiler that way and expect to get circulation. The water pressure on the discharge side of the check valve must drop below the pressure on the other side before the check can open and allow the water to circulate. With his present hook up the best he could expect would be to have equal pressure on both sides of the check valve and it would stay closed and prevent circulation.

W.A.D. could install a circulating pump in the return line but this would not give good results as the 100-gal. tank would be shorted out of the circulating system as can easily be seen in Fig. 1. I believe if he would change the return line as in Fig. 2, hooking it into the drain line in the bottom of the boiler provided he has one, or into the top of the boiler with a tube going down in the boiler close to the bottom of the tank as shown by the dotted lines, he will get good circulation.

DONALD OSTERHOUDT.
Poughkeepsie, N. Y.

* * *

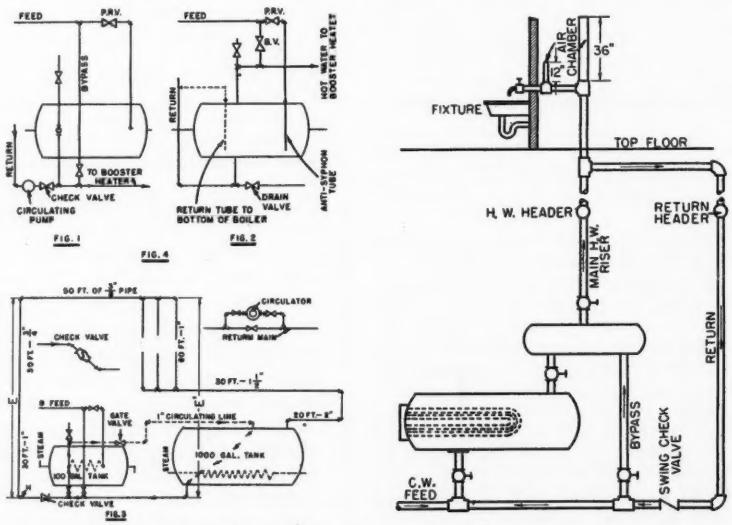
IN ORDER to analyze this problem, it is necessary to have a diagram showing the general arrangement of the complete system. This, I gather from the information supplied, is approximately as shown by Fig. 3. The first thing that strikes one, is, that there is no natural circulation through the 1000-gal. heater coil, which, I understand is the main source of hot water. This looks like a small storage heater, but, as a matter of fact, it is connected as an instantaneous heater, and, except when water is being drawn, it is practically inoperative.

If the main heating were done in the large tank water would circulate freely in this tank, as long as steam was on the coil, and the whole 1000 gal. would eventually heat up. This would not be materially affected by circulation in the piping system, the chief advantage of this arrangement is that there would be no delay in getting hot water to the faucets.

If the small heater were in the circulating system, and all heating done there, we ought to have free circulation between its heating coil and the large tank. This could be provided by installing a 1 in. circulation line—shown dotted in Fig. 3. It would not be well to rely upon circulation through the whole system, as, at best, this would be very sluggish.

What somewhat confuses me, is the statement that there is no trouble with heating, but only with circulation, for, if I rightly understand the connections, the heating in the small tank would not be very adequate, unless, of course, the coil had very large capacity, and I cannot help feeling that the conditions would be much improved by more effective heating, which would be provided by the installation of the circulating line.

After doing this, if W.A.D. finds it advisable to get better circulation through the return line, I would suggest that he first turn his attention to the ⅜ in. line. The only thing that provides circulation, is the difference between the weight of a column of cool water "E" and a column of warmer water "E",



Proposed connections for hot service water system

and this gives us very little power to overcome friction.

Such a small pipe as ⅜ in. should not be used for circulation, especially as, if it has been long in service, it is probably partly blocked by rust and sediment. Then too, the check valve probably stops circulation. When a check valve is used, it should have a very light clapper, and should be set at an angle, as shown, so that it will tend to open, and only close against reverse flow.

If, after doing everything possible to see that there is as little resistance in the piping system as possible, W.A.D. still thinks that he should have better circulation, he can install a small pump, or circulator in a bypass on the return line. There are several makes of circulators on the market, and any plumbing supply house should be able to furnish one. W.A.D. may possibly find, that the smallest is for 1½ in. pipe, and this should be satisfactory. It should be so valved that the system can be operated either with, or without it.

Only gate valves should be permitted in the circulating system.

W.A.D. refers to the apparent drop in pressure between the supply and point H. When a large amount of water is being drawn off, there will undoubtedly be a considerable drop in pressure owing to friction, but this should cause no trouble, if we are getting enough water.

When no water is being drawn, it is impossible that there should be any material difference in pressure between any parts of the system, as if there were, water would immediately flow to the low point and equalize it. Of course, it is possible that there is a difference between the actual pressure on this system, and the nominal pressure of the supply service.

JAMES O. G. GIBBONS.
Bloomfield, N. J.

* * *

IN ORDER to make hot water circulate, the direction of flow must always be upward from the heater, as hot water circulates due to the difference in weight. As this difference is rather small, any hindrance such as globe check valves and piping with a downward direction will immediately stop circulation. Swing check valves should always be used.

Another common cause of non-circulation is air trapping or the accumulation of air at the highest point of the hot water line. This can be overcome by placing an air chamber at this point. In any event, all of the hot water outlets should be provided with air chambers which pocket the air as well as prevent the annoyance of water hammer.

It is obvious that the circulation of hot water in W. A. D.'s system is impeded as the booster heater outlet is below the other heater. Also hot water is taken out of the middle portion of the tank and the hottest water is at the top. Arranging the layout as shown in the sketch (Fig. 4) will give the best results.

If on account of long runs of piping you do not get proper circulation, you might place a circulating pump with a capacity equal to the average hot water consumption per hour. The pump motor should be operated with a thermostatic switch.

Lima, Peru H. P. VALERIUS

Refrigerating Machine Capacity

ON PAGE 40 of the January issue, N. M. M. asked a question about routine calculation of refrigeration production as a measure of plant output. As the refrigerating load and the operating conditions vary from day to day and from season to season, I believe it best for N. M. M. to figure out a tonnage chart that will consider such changes. Then he will have reliable charts of his own for that individual plant and his calculations of capacity will be as near correct as is possible to have them.

The following facts and figures will give him the method used. From the number of cylinders, their diameter and length of stroke, figure the displacement per minute at the different speeds. (Theoretical displacement.) As no machines are perfect, it is customary to allow about 90 per cent of the theoretical displacement as the actual displacement when considering ammonia compressors of the vertical single acting type.

Next arrange to be able to take temperature readings of the liquid ammonia as it leaves the condenser. A thermometer well should be in this liquid line, but very close to correct readings can be taken by insulating a thermometer in close contact with the line. The temperature of the saturated vapor in the evaporating coils can be found in the Ammonia Tables. Knowing the temperature of the liquid and the vapor is necessary when it is desired to find out the refrigerating effect of the ammonia. The refrigerating effect is really the heat absorbing power of the ammonia and is expressed in B.t.u. per pound.

To find the refrigerating effect, refer to the Ammonia Tables and subtract the heat content of the liquid from the heat content of the saturated vapor. Example—Temperature of liquid leaving condenser 86 degrees; heat content 138.9 B.t.u. Temperature of vapor in evaporator 5 degrees, at 19.6 lb. gage pressure; heat content 613.3 B.t.u. Subtracting gives 474.4 B.t.u. as the refrigerating effect of 1 pound ammonia under the stated temperature conditions.

Next divide 200 B.t.u. by the refrigerating effect and you have the theoretical amount of ammonia evaporated per minute to produce 1 t. refrigeration in 24 hr. (200 B.t.u. per min.; 12,000 per hr. or 288,000 per 24 hr. equals 1 t. refrigerating capacity.)

Under ordinary operating conditions about 16 per cent must be added to the theoretical amount of ammonia. This added amount is the ammonia that is evaporated in cooling the liquid from the temperature at which it leaves the condenser to the temperature of the saturated vapor in the evaporating coils.

Next we consider the vapor after it leaves the evaporator. The vertical single acting ammonia compressor is a dry gas unit and is operated at its greatest efficiency when the vapor reaches the compressor suction valves at a temperature about 5 deg. above the saturated temperature. On this type compressor the vapor will have a temperature of between 50 and 75 deg. at the end of the suction stroke. The increase is caused by the vapor coming in contact with the warm metal surfaces of the valves, piston, heads and cylinder walls. We will consider 65 deg. as a fair average.

Then the next step is to change the pounds of liquid evaporated to cubic inches of superheated vapor. At 19.6 lb. gage pressure and a temperature of 65 deg., 1 lb. ammonia will occupy 9.2 cu. ft. Then divide the actual displacement of the compressors by the volume of the actual amount of ammonia evaporated and the result is the actual tons refrigerating capacity.

The displacement figures 7000 cu. in. for 1 ton refrigerating capacity and 12,000 to 14,000 cu. in. for 1 ton ice making capacity were gotten up nearly 50 yr. ago. They were based on theoretical conditions and did not consider variations in volumetric efficiency, superheating of suction vapor in the cylinders and different ammonia temperatures. Many theoretical tables are still in use for displacement, tonnage and horsepower per ton and it will be no-

Tonnage calculation. Compressor; 2 cylinder vertical single acting; dia. 11½ in.; stroke 14½ in.; speed 70 r.p.m. Theoretical displacement 210,854.3 cu. in. (122 cu. ft.). Actual displacement at 90 per cent volumetric efficiency, 189,768.9 cu. in. or 109.8 cu. ft.

Condenser liquid temp., deg. F.	86
Suction pressure, lb. per sq. in. gage	19.6
Evaporator vapor temp., deg. F.	5
Heat content, cond. liquid, B.t.u. per lb.	138.9
Heat content evap. vapor, B.t.u. per lb.	613.3
Refrigerating effect, B.t.u. per lb.	474.4
Theoretical ammonia per ton, lb. per min.	0.421
16 per cent added for liquid cooling, lb.	0.067
Actual total ammonia per ton, lb. per min.	0.488
Ammonia vapor superheated to 65 deg., cu. ft. per lb.	9.2
Ammonia vapor at 65 deg. per t. per min.	
in lb.	4.4896
in cu. in.	7758
Actual tons refrigerating capacity produced	
Actual displacement divided by 7758	24.46

ticed that there is nearly always a foot note telling the reader to add anything from 15 to 50 per cent for actual performance.

With a little study and practice it is an easy matter for the engineer to arrive at correct figures in most of his daily operating problems.

Bradley Heights, Md.

A. G. SOLOMON

Gage Glass Troubles

WE CARRY 105 lb. steam pressure and have trouble with water gage glasses. It does not seem as though they last as long as they should. I pack both ends of the glass as near the same as possible and am careful to not tighten the nuts too tight on either end, just enough to avoid leaking, but the top or steam end of the glass cracks and blows out quite often. Some glasses last 3, 4, or 6 mo. One did last for nearly 2 yr. but others blow out in 2 or 3 da. and it is always at the top end of the glass.

Can you suggest some way to overcome this little trouble of water glass blowing out? A. H. P.

APPARENTLY you are using the correct method of installing the glasses and offhand, if you are getting from 6 mo. to a year's service it would seem that you are doing fairly well, although if the gage glass breaks in a few days there is, of course, something wrong.

It may be that the two connections are not lined up accurately and that there is a strain on the glass after the nut is tightened. Again it may be that you are scratching the glass with the nut or possibly with the wrench or when you clean it. If you are now tightening the top nut first, reverse the process and try tightening the bottom one first, being extremely careful that the glass is not scratched. A touch with a piece of steel or piece of wire will scratch the glass so that it cannot be seen but will start a larger crack and eventually it will break as soon as it is warmed up.

Perhaps you do not warm the glass up sufficiently. We are quoting the following paragraphs of rules for the care of power boilers suggested by the A.S.M.E.:

"When a water glass has broken, remove the broken pieces and slowly open the valves to blow out any remaining pieces. Before inserting the new glass, see that the drain is open and that the glass is of the exact length required and that the connections are in line. Insert the glass with packing and set up the stuffing-box nots, taking care not to set them up too tight; then warm the glass by opening the top valve slightly and let a small current of steam flow through the glass. Close the drain cock after the glass is sufficiently warmed, open the bottom valve slightly and when the level of the water in the glass has become stable, open the bottom valve wide and then open the top valve wide.

"Unless the water glass is provided with a guard to protect the operator while replacing water glasses on boilers under pressure, or unless the operator wears a mask, the valves shall be operated only by remote control. A suitable water-glass guard may be made in the form of an inverted cone of No. 22 black iron wire screen of ⅛ in. mesh."

It would seem as though this is a good time to collect some badly needed data as to how long gage glasses do last in normal operation. We do know that with high pressures gage glass must be protected from erosion and corrosion by mica but there seems to be little information on the effect of other factors at lower pressures. If you have any data on gage glass replacements send it in and we will attempt to tabulate it and draw conclusions and perhaps establish standards for gage glass life. Include the total number of border gage glasses in the plant; the operating pressure; total replacements per year; minimum, average and maximum length of service; number of times each water column is blown down each day.

Letters and Comments

Hogged Fuel

FROM WOOD FIRING furnaces I have seen, I would answer G.L.B.'s question on p. 80 of the April issue as follows: From the information given, G.L.B. has a grate area of about 42 sq. ft., so that firing wood and bark of 40 per cent moisture at 100 per cent rating he is burning about 55 lb. per sq. ft. of grate surface. This is not excessive since it amounts to only 33 lb. dry wood per sq. ft. With this type of firebox, he is limited, however, to about 40 lb. dry wood per sq. ft., or a top rating of 125 per cent.

To insure the maximum rating, I would recommend the following: Good results have been had both with and without hogging, but I generally favor hogging because of the far more rapid combustion possible. The objection to hogging (aside from the power consumption) is that the carryover may be higher, but that may be minimized by proper operation.

The size of sliver is important. Its cross section should be as small as possible to provide rapid and complete combustion, but it should be as long as possible to make it heavy and less liable to carryover into the boiler. While ¼ in. thickness is good, ½ in. is common practice, but the length is difficult to control except through the design of the hogger.

G.L.B. is probably operating only on natural draft, with all the air through the grates and front doors. A large amount of overfire air is necessary, but it should be from the sides or rear so that it does not blow the wood particles directly into the boiler. Juggling the ratio of overfire air and air through the grates, to reduce the latter, will reduce the velocity of air through the fuel bed and cut down on the carryover. A small overfire air fan, discharging through firebrick nozzles set in the side walls or bridge wall, is used successfully by some plants. A velocity of at least 8000 ft. per min. is necessary in a small boiler, and need be used only at higher loads.

Hogged fuel feed should be arranged to feed in a thin stream and spread out so that it will start burning in suspension. Many boilers have a splash plate at the bottom of the fuel spout to help distribute the wood in the furnace. It is axiomatic, of course, that higher furnace temperature improves combustion, but this may be limited by the brickwork or the boiler. If fluxing of the brickwork is experienced, it is well to remember that some operators have decreased brickwork maintenance by using low silica brick.

Staten Island, N. Y. R. ATLAS

Eliminating Stack Losses

OFTEN ONE NEEDS to know, at least approximately, the fuel loss, due to the heat contained in the gases discharged from a boiler. We can get this information by subtracting the temperature of the air entering the furnace, from that of the flue gases, then multiplying the result by the number of pounds of flue gas, per pound of fuel, and by 24, which is the assumed specific heat of the gas, multiplied by 100. We then divide the result by the B.t.u. value of the fuel, and get our answer.

For instance:—Fuel 14,000 B.t.u.; air 70 deg. F.; flue gas 650 deg. F. and 19 lb. per lb. of fuel. Substituting in the formula

$$\frac{(650 - 70) \times 19 \times 24}{14{,}000} = 18.9 \text{ per cent loss.}$$

This is quite obvious and simple, but unfortunately, there is no practical method of directly weighing the flue gas. On the other hand, if we have a CO_2 recorder, we can estimate the weight with a considerable degree of accuracy. We probably have an at least approximate figure for the B.t.u. value of the fuel, and fortunately, the theoretical number of cu. ft. of free air, at ordinary room temperature, required per pound of fuel, is almost exactly one per cent of the number of B.t.u.'s in the fuel. For 14,000 B.t.u. fuel, then 140 cu. ft., which is about 140×0.075, or 10.5 lb.

Provided we know the theoretical maximum per cent, CO_2 obtainable with that class of fuel we can find the excess air from the percentage of CO_2 in the flue gas. The theoretical maximum may be assumed to be: for pure carbon, 20.9 per cent; for bituminous coal, 18 to 19 per cent; for anthracite coal, 19.5 per cent; and for fuel oil, 15.5 per cent, although for some oils it may be only 15 per cent.

In flue gas percentages, CO_2 plus O_2 plus CO equals the maximum possible

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CO_2 but unless we make a more or less, complete analysis, we shall not know the CO in the gas. As this is probably small however we can ignore it and assume that the CO_2 plus O_2 is equal to the maximum possible CO_2. For instance, if the fuel is pure carbon, the theoretical maximum per cent of CO_2 will be 20.9, as all the oxygen in the air is converted into CO_2 and 20.9 is the percentage of O_2 in the air.

If our recorder indicated 10 per cent CO_2 then 10 plus 10.9 equals 20.9, so the relation between oxygen consumed to produce CO_2 and that not consumed, is 10 to 10.9 so there is 109/100 or 109 per cent excess. If we were burning bituminous coal, having a possible theoretical maximum production of 18 per cent CO_2, an amount of oxygen representing 18 per cent of the volume of the air, is all that could combine with the carbon to form CO_2, the remaining 2.9 per cent combining with the other constituents of the fuel, so if our reading was 12 per cent CO_2 the ratio of consumed available O_2 to the unconsumed available O_2 would be 12 to 6, and there is 6/12 or 50 per cent excess.

With oil, we may consider 15.5 per cent CO_2 to be the maximum, if we find 14 per cent, there will be 1.5 per cent oxygen which might have combined with the carbon in the fuel, if sufficient carbon had been present, so there is a deficiency of carbon, or an excess of air, whichever way we like to look at it, the ratio being 1.5/14, which is about 10 per cent excess.

If preferred, the following equation, based upon the percentage of nitrogen in the air (.791) may be used, giving approximately the same results. In this E is equal to the percentage of excess air.

$$E = \frac{(CO_2 \text{max} - CO_2 \text{act.})\ 0.791 \times 10{,}000}{CO_2 \text{actual}\ (100 - CO_2 \text{max})}$$

In the case of 14,000 B.t.u. bituminous coal, we found that we need, theoretically, 10.5 lb. of air and with 12 per cent CO_2 we have 50 per cent excess, which means 15.75 lb. of air. If we ignore the incombustible we can say that we also have one pound of fuel, making altogether 16.75, or say 17 lb. Using this in our original example instead of 19 lb., we should get $17/19 \times 18.9$ or about 17 per cent excess.

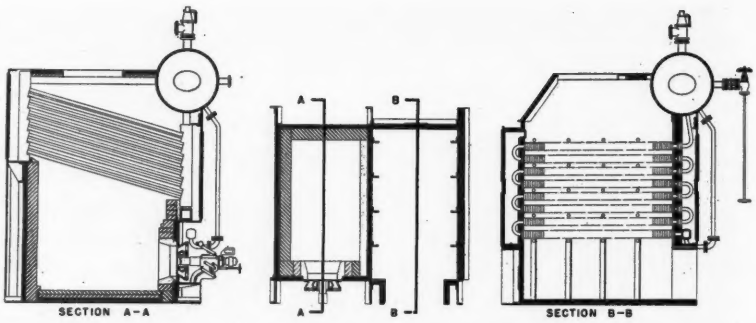
Theoretically, the methods employed are not particularly accurate, but in view of the fact, that in actual operation, the amount of flue gas, as well as other conditions are continually changing, the results obtained, are probably as close as it is possible to get, under ordinary circumstances.

The chief lesson to be learned from the above, is that the lower stack temperature, the lower the fuel loss, provided—and this is a most important provision—we do not lower the CO_2. If that happens, we had better find out why, probably it means excess air and quite possibly a leaky setting.

Bloomfield, N. J. J. O. G. GIBBONS

Waste Heat Recovery

LAUNCHING of the 15.5 knot, 8875 t. M. S. "Donald McKay" last spring was memorable in that it was the first of the U. S. Maritime Commission's Class C2 Diesel vessels to take the water; it was named after a famous square rigger of the clipper ship era and it was christened by Donald McKay V, 7 yr. old, great-great-grandson of Donald McKay, the master designer and shipbuilder of Boston.



Waste heat boiler for Diesel vessels

It has more than tradition behind it, however, and includes all the features made available by modern engineering, not the least interesting being a Foster Wheeler combination waste heat and oil fired boiler that offers great possibilities in the industrial field as well as at sea. The combination of flexibility with efficient waste heat recovery from the exhaust places the Diesel in an enviable position as far as overall fuel economy is concerned.

The boiler is located amidship, slightly aft and above the main 6000 shaft hp. main engine. Gases from the engine pass directly through one section of the boiler to the stack. This section is made up of 2 in. diam. tubes covered with cast iron, gilled ring armor 4⅝ in. diameter. In addition to increasing the effective heating surface about six times, the shrink in rings protect the tubes from sulphuric acid corrosion due to condensation when the engine is shut down.

Immediately adjacent, with a common steam drum, is the second section, of conventional straight tube design fired by an oil burner. The boiler is designed for 125 lb. pressure but may be operated at lower pressures if desired. It is the only heating unit on board and under normal operating conditions at sea the steam generated by the engine exhaust is sufficient for all needs.

Reminder Prevents Freezeups

WITH THE ADVENT of cold weather added responsibilities are placed on the plant maintenance department. Perhaps the most important of these is the need of taking steps to prevent losses resulting from the freezing of water in exposed piping or machines. Wherever service conditions make it possible, all such equipment should be thoroughly drained and a sufficient number of drip points provided to avoid any accumulations of water in low points of the system. In the case of steam or water piping, unions should be disconnected, all valves except the main shut-off valve opened, valve packing glands and bonnet joints loosened, caps and plugs removed from dirt pockets and strainers, and provision made for the positive drainage of any pocketed water in other accessories. Leakage of water into the system should also be guarded against by either blanking off the inlet valve or breaking a joint in the main just beyond it to take care of any drippage. Drainage traps in plumbing systems from which it is inadvisable to remove the water should be protected with an anti-freeze preparation such as calcium chloride and the liquid surface covered with a thin layer of machine oil to prevent evaporation.

If water must remain in exposed piping or other equipment throughout the winter months and if the use of anti-freeze solutions is impractical, heat must of course be provided at all points where freezing is likely to occur. There are, however, many instances where equipment is used intermittently and it is often more practical to drain off the water at the beginning of each idle period. Where this is true, the human factor must be reckoned with and some form of reminder is needed to jog the memory of personnel responsible for doing the job. One large industrial concern uses painted signs for this purpose, placed on the doors of sheds where portable machines such as concrete mixers, air compressors and excavation pumps are stored and near main controls of stationary devices. These signs bear the legend "Have You Drained the Water"? and are made especially effective by using large red lettering outlined with a border of white icicles against a light gray background.

When small turbines with carbon gland rings are idle for any length of time the rings should be removed and the shaft slushed with heavy oil. Left in place, corrosion may occur due to moisture and electrolytic action.

Bethesda, Md. S. H. COLEMAN

* * *

Electrochemical industries consume more than 10 per cent of the electrical energy produced in the United States, some 13,324,000,000 kw-hr., of which the aluminum industry alone uses almost 2,600,000,000 kw-hr.

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Lunkenheimer, in its line of "Ferrenewo" and "Renewo" valves, first of all offers the buyer a range of pressures to provide the most *efficient* valve for every job. In addition, you have the choice of either regular or plug type seats and discs, depending upon the particular service condition . . . a feature that literally *doubles* the breadth of this line and further assures an absolutely rock-bottom cost for every application.

But this wider choice of patterns by no means complicates the use of Lunkenheimer "Ferrenewo" and "Renewo" valves. The fact that parts other than seats and discs are *also* interchangeable means that fewer parts need to be kept on hand, repairs are facilitated, and ordering and handling are simplified. Here, indeed, is an example of engineered superiority worthy of your immediate investigation.

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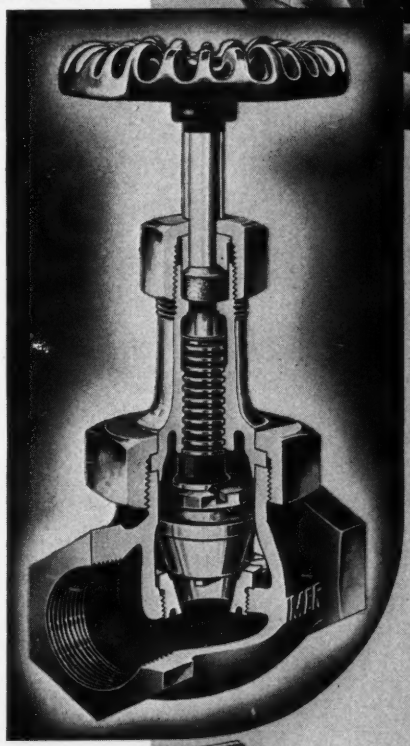
One of the best ways to convince yourself that "Ferrenewo" and "Renewo" valves offer you a decided advantage, both in cost and long term satisfaction, is to ask our distributor to compare them part-for-part with any valve of similar type which you may be using. It will be a revelation that you can actually *see* so much difference with the naked eye!



IRON BODY "FERRENEWO"
FIG. 1021-P
150 lb. S.P.

BRONZE "RENEWO"
FIG. 73-P, 200 lb. S.P.
FIG. 16-P, 300 lb. S.P.

FIG. 1857-P
150 lb. S.P.
ALL-IRON

FIG. 1878-P
350 lb. S.P.
BRONZE

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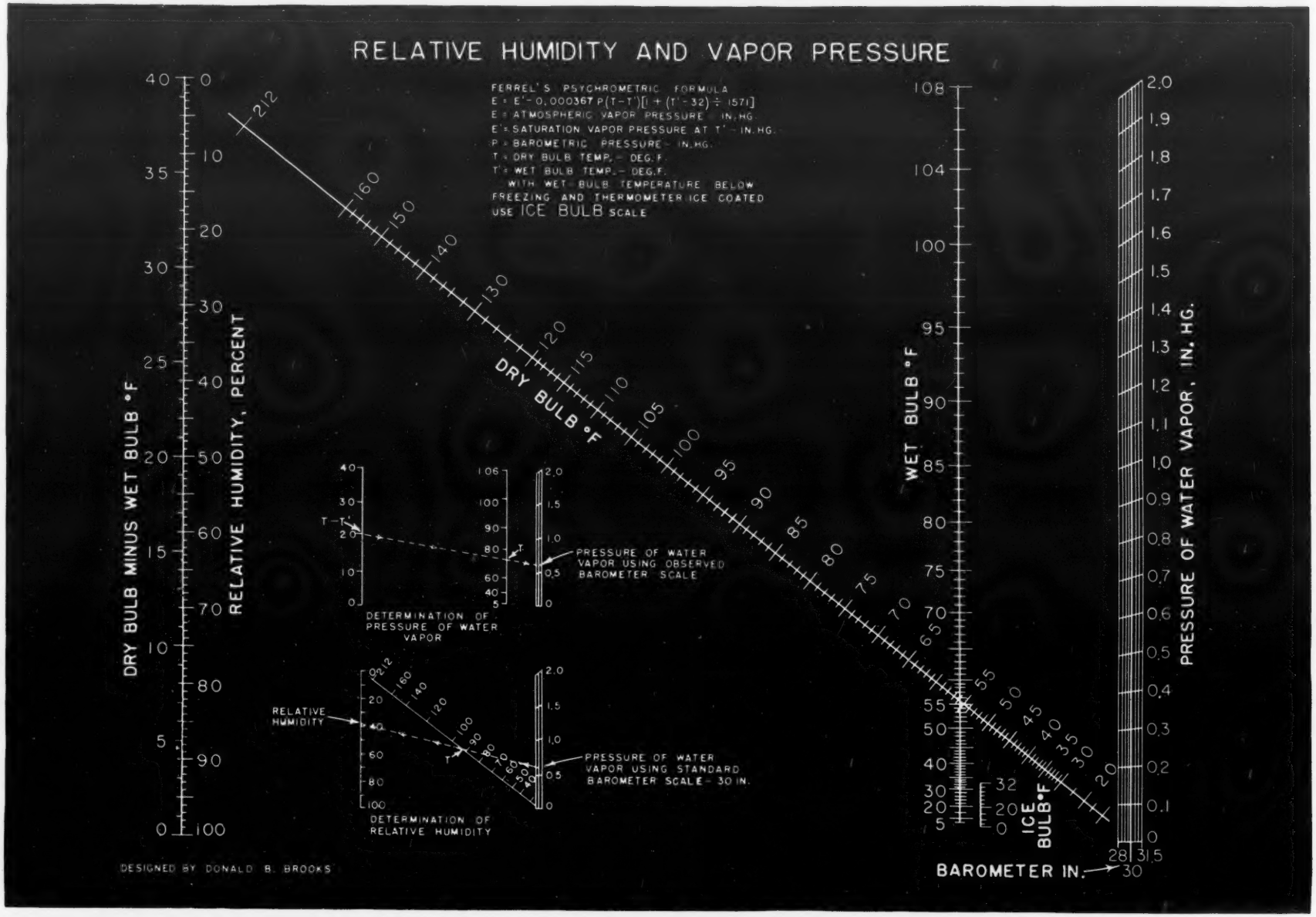
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FERREL'S PSYCHROMETRIC FORMULA
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E = ATMOSPHERIC VAPOR PRESSURE - IN. HG.
E' = SATURATION VAPOR PRESSURE AT T' - IN. HG.
P = BAROMETRIC PRESSURE - IN. HG.
T = DRY BULB TEMP. - DEG. F.
T' = WET BULB TEMP. - DEG. F.
WITH WET-BULB TEMPERATURE BELOW FREEZING AND THERMOMETER ICE COATED USE ICE BULB SCALE
DRY BULB MINUS WET BULB °F
RELATIVE HUMIDITY, PERCENT
DRY BULB °F
WET BULB °F
ICE BULB °F
PRESSURE OF WATER VAPOR, IN. HG.
BAROMETER IN.
PRESSURE OF WATER VAPOR USING OBSERVED BAROMETER SCALE
DETERMINATION OF PRESSURE OF WATER VAPOR
RELATIVE HUMIDITY
PRESSURE OF WATER VAPOR USING STANDARD BAROMETER SCALE - 30 IN.
DETERMINATION OF RELATIVE HUMIDITY
DESIGNED BY DONALD B. BROOKS

Boiler Plate

During the past 100 yr. boiler practice has changed and it has been up to the steel man to make boiler plate to withstand an increase in pressure of from 10 to 2000 lb.

By Dr. W. G. Theisinger*
Welding and Metal. Engineer
Lukens Steel Co.,
Coatesville, Pa.

MANUFACTURE of boiler plate in the United States has run the gamut of the series of processes developed for the making of iron or steel. Among the requirements, as early as 1817, we find specifications calling for boilers to be made of wrought iron instead of cast iron or copper, the materials previously employed. Until 1830, boilers were rarely worked above 10 lb. per sq. in., and the usual pressure was something less than 7 lb. Then the pressures were increased to 30 and 40 lb. per sq. in. and inspection recommended but not required. From 1864 to 1869, there were 288 boiler explosions: 36 per cent of the failures were due to defects of construction, either of materials or workmanship; and 25 per cent resulting from neglect during the operation of the boilers. This not only indicated the need of improvement in materials, but also the necessity for regular competent inspection. Convincing proof of the value of inspection was offered in 1881, when it is reported that of the 15,000 boilers regularly inspected there were only two boiler explosions.

From the standpoint of the boiler plate material itself, the use of wrought iron for boiler plate was a decided improvement over the previously used cast iron and possibly some of the so-called charcoal iron but the significant period in the boiler plate industry must have been around 1860 when Bessemer steel was being introduced and the Siemens-Martin or open hearth process was being developed. It is claimed that as early as 1855 the boilers on the Mississippi steamboats were made of steel produced by Kelly's Pneumatic Process, the contemporary of the Bessemer process. By 1875, Holley had produced boiler plate made from Bessemer steel that could be flanged backward and forward and doubled upon itself. Since we are interested in quality, the development of paramount importance was the Thomas-Gilchrist process, introduced in 1883 making possible the basic production of steel wherein the removal of phosphorus and to some extent the sulfur was effected.

Also during this period, considerable attention was being brought to bear on methods of testing boiler plate material. In 1875, when the United States government began requiring that plates used in construction of steamboat boilers be stamped with their tensile strength, the Lukens Steel Co. having been the first mill to roll boiler plate in America, purchased a testing machine and began investigating the physical properties of iron and steel. Today the manufacture of boiler plate steel is carried out in the basic open hearth to practically the exclusion of all other steel making processes. From the standpoint of quality, the open hearth lends itself readily, because the charge once melted can be kept in that condition while fluxes and other materials are added until the analysis of the melt has attained the right chemistry to give the desired physical and engineering properties.

During the melting period, the refining action takes place by bringing the melt in contact with the slag in order to flux out the impurities. This so-called "boil" depends upon carbon for the duration of the action and upon silicon for its intensity—both necessary for quality steel. Alloying additions are made while the melt is still in the furnace to permit complete and uniform solution.

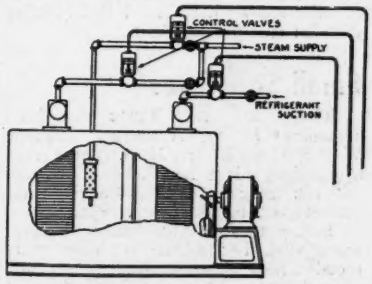
After the ingots of boiler plate steel have been poured and solidified, they are removed from the moulds, reheated in the soaking pits and rolled into slabs that are approximately one half the thickness of the original ingot. These slabs are allowed to cool and are inspected for surface imperfections. Such defects are removed by chipping or with the acetylene torch and even machining the slabs is resorted to at times. The conditioned slabs are reheated and rolled to the desired pattern. Each boiler plate is inspected after rolling and tensile and bend test specimens taken from every plate in accordance with the requirements.

In addition to the ASME S-1, or 33,000 to 65,000 lb. per sq. in. tensile grade, there is now available a group of steels of higher tensile properties. Greater service pressures and temperatures are possible by the use of the high strength steels, thereby employing less thickness than if the lower tensile grade were used. The 70,000 lb. per sq. in. minimum tensile steels have been adopted for many vessels and the forming and welding of such material has assumed regular shop routine. Most of this steel has gone into vessels constructed in accordance with par. U-68, requiring x-raying and stress relieving. By a combination of chemical elements, the desired physical properties are obtained not only in the plate material, but also in the deposited weld metal. The so-called 70,000 lb. per sq. in. minimum tensile steels for boilers and other pressure vessels are listed in the table.

Low Humidity

IN PROCESS WORK where low humidity is necessary, refrigeration to reduce humidity may be unduly expensive. In this case the moisture may be reduced by passing all or a portion of the air over silica-gel, calcium chloride, sulphuric acid or other materials which have a high affinity for water. In one case in England it was found that old shredded cotton fire hose, hung in the air tunnel, gave adequate regulation; absorbing moisture when the humidity got too high; releasing it when the humidity got too low. When temperature control is also necessary, heating and cooling coils must be added as needed.

If the dehumidification necessary is not great so that refrigeration is economical a combination of cooling and heating coils can be used to give both humidity and temperature control as shown by the drawing. By cooling the excess moisture is condensed out and



Typical air conditioning layout

the temperature can be brought up to the desired point by the heating coil. Humidity is controlled by varying the two temperatures as necessary to give the desired relative humidity. Well water of 50-55 deg. F. is often sufficient to give the cooling needed. This same drawing shows a steam atomizer for use in place of the cooling coil when humidification rather than dehumidification is necessary. The refrigeration effect necessary for very low temperatures and humidities is shown by a chart on page 112 of the February, 1937, issue.

*Welding and Metallurgical Engineer, Lukens Steel Co. In presenting this paper before the N. B. of B. & P. V. Inspectors, the author acknowledged the assistance of Charles L. Huston, now first vice president, in active plant service with the company since 1875 and an acknowledged authority on the manufacture of boiler plate.

Tabulation of several of the 70,000 lb. boiler plate steels. Data based on stress relined plates.

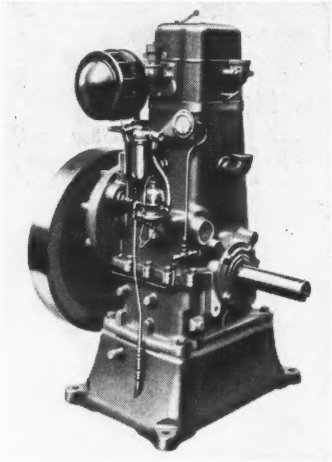
Steel	A.S.T.M. Desig.	A.S.M.S. Desig.	Ten. St. lb./sq.in.	Yield lb./sq.in.	Elong. %	Analysis in per cent C	Mn	P	S	Sc	Mo	Cr.	Ni
Carbon-Silicon	S-27	A-150-38	77,000	46,000	28	.27	0.72	0.016	0.024	0.23	...	...	...
Chrome-Manganese-Silicon	S-28	A-202-37T	81,000	58,000	23	.16	1.35	....	....	0.74	...	0.51	...
Low-Carbon-Nickel	S-43	A-203-37T	75,000	52,000	26	.17	0.75	....	....	0.21	...	...	2.25
Molybdenum	S-44	A-204-38	75,000	55,000	32	.20	0.83	....	....	0.24	0.48	...	...

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Diesel Engine

THE STOVER MFG. & ENGINE CO., Freeport, Ill., announce a new line of Diesel engines, equipped with the Lanova combustion chamber, that develop more power per unit of displacement and per pound, and sold at proportionately lower cost.

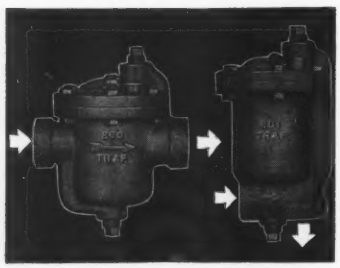


These new Stover Diesels are available in four sizes and with a variety of mountings. The 7½ and 10 hp. models are single cylinder. The 15 hp. and 20 hp. models are of the twin cylinder type. The illustration shows the conventional stationary type of mounting. The twin cylinder models have No. 1 Bell housing with an enclosed flywheel.

Small Size Traps

TWO NEW STEAM TRAPS have been announced by the Armstrong Machine Works, Three Rivers, Mich. These traps are designated as No. 800 and 801, and will supersede the small 200 Series traps formerly produced by the company.

Features of the new traps include: more rugged construction, with more metal added at connecting points and around water passages; freer flow of water, due to redesigned cross-section of water passages; one-piece stainless steel bucket; and single casting size for both ½-in. and ¾-in. pipe connections.

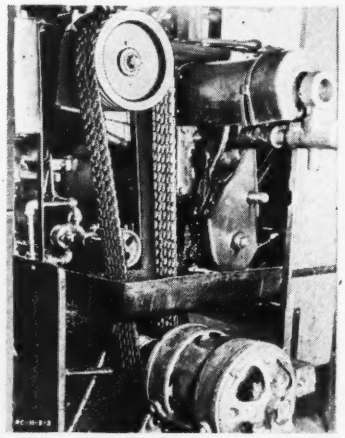


The No. 800 Trap is for use on straight-through pipe connections, and the No. 801 for standard angle connections. Either trap may be equipped for "Blast" Trap Service by using buckets which have an auxiliary thermic air vent. When thus equipped, these traps are said to be capable of handling from 50 to 100 times as much air as regular traps.

Both new traps have the inverted bucket operating principle, free-floating valve mechanisms, self-scrubbing action, heat-treated chrome steel valve seats, and stainless steel valve levers.

Neoprene Sectional V-Belts

INSURANCE against failures can be had by guarding the belt against those forces tending to destroy it. Then, speed of replacement can be achieved by using a belt for those "hard-to-get-at" locations that can be installed without partially tearing down the machine. These principles, it is claimed, are incorporated in a belt manufactured by Manheim Manufacturing & Belting Co., Manheim, Pa., shown in the accompanying illustration. It consists of short belt sections of V-belt cross-section which are fastened by buttoning the bottom of one end of a section to the top of the other end of another section. Thus, a complete belt can be formed by joining together enough sections to provide the drive, and this belt can be removed or installed by simply unhooking or hooking any two sections.



These belts are available in neoprene-bound fabric styles. The accompanying photograph illustrates one application where the neoprene bound V-belts are used under the exacting service requirements of automatic screw machine driving in a location where the belt is constantly exposed to cutting oils. The belt has seen 21 months of service despite daily exposure to cutting oils.

Smoke Alarm

PHOTOSWITCH Electric Eye Smoke Alarm with Densometer, made by Photoswitch, Inc., 21 Chestnut Street, Cambridge, Mass., continuously observes the smoke passing through the flue. It indicates the smoke density on a 4⅜ in. dial which reads from zero to one hundred. This alarm consists of three elements, a photoelectric control, densometer-signal combination shown in the illustration and light source. The light source and photoelectric control are mounted on opposite sides of the flue or breaching, and are alined through simple entrance tubes or windows so that the beam projected from the light source strikes the eye of the control. The densometer may be placed at any convenient location in the boiler room, usually near the other furnace controls, and is wired to the photoelectric control.

Cooler

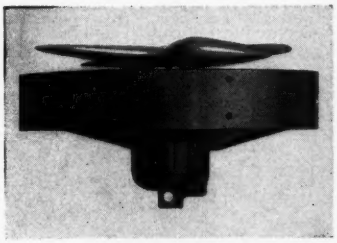
THE YORK ICE MACH. CORP., York, Pa., announces a large-capacity milk cooler of a new, compact arrangement, cabinet type and practically 100 per cent stainless steel, inside and out.

The entire cooler, except ammonia headers, cabinet bottom support, and gravity-feed ammonia system, is of highly-polished stainless steel. Milk cooling sections are die-stampings, welded and polished, permanently fixed to the ammonia headers and spaced for easy cleaning. Ammonia leaks with this design are eliminated.

Advantages of this new unit are: attractive appearance, simplicity of design, compactness, accessibility, and small floor space requirements. The unit has hinged covers all around, corrugated cooler sections—thinner—with maximum surface contact, fixed ammonia connections, and the entire assembly can be quickly and easily cleaned.

Ventilating Fan

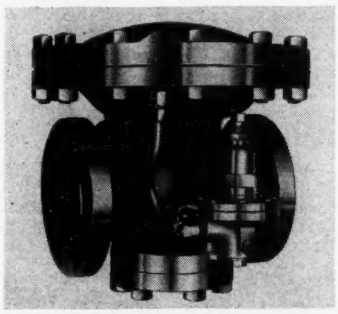
THE TRUFLO FAN CO., 578 Main St., Harmony, Pa., announces a new line of roof ventilating fans. Truflo Ventilating Fans are available in 48, 42, 36, 30, 24 and 18-in. sizes with air exhaust capaci-



ties ranging from 40,000 to 2,000 cu. ft. per min. Propellers are made of high quality cast aluminum alloy. Motors can be had in open, totally enclosed non-fan cooled, totally enclosed fan cooled, and explosion proof types. Inside diameter of ventilating stack and amount of air to be delivered determine the proper size.

Reducing Valve

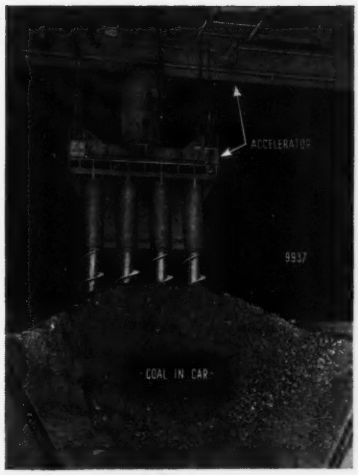
A NEW Pilot Operated Pressure Reducing Valve Type 92 for steam service announced by the Fisher Governor Co., Marshalltown, Iowa, is much smaller and more compact than the ordinary pilot operated valve. It functions without any auxiliary operating medium and has unusually large capacities. High-tensile iron ribbed construction imparts extra



strength to bodies and diaphragm casings. Two pilots for high or low pressure service are available and these are interchangeable on all sizes. It is equipped with a removable pilot strainer separate from the valve body. All parts of the valve are readily accessible for inspection. There are 10 sizes available which range from ½ to 6 in. Pressure ranges run from 1 to 200 lb.

Coal Accelerator

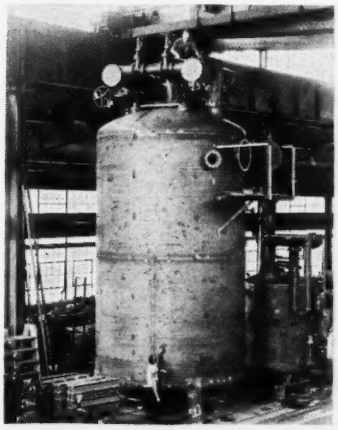
STEPHENS-ADAMSON MFG. CO., Aurora, Ill., announce the development of a new Coal Accelerator to facilitate unloading of high moisture content, frozen coal and moist slack. The construction and operation of the accelerator is evident from the illustration. It is mounted on a traveling crane and the control is flexible, permitting rapid changes of position, either vertically, horizontally or laterally. The accelerator is easily started or stopped and the direction of the screws can be quickly reversed. At one well known eastern power station, quarter inch slack containing a major portion of bug dust combined with mois-



ture, it is said to have cut the coal unloading time one-half. Formerly it required four men one hour to bring the contents of a 70 t. dump car down to the track hopper. With the adaption of the new coal accelerator the time was cut one-half, only two men were needed to do the manual work while a third operated the accelerator.

Deaerating Heaters

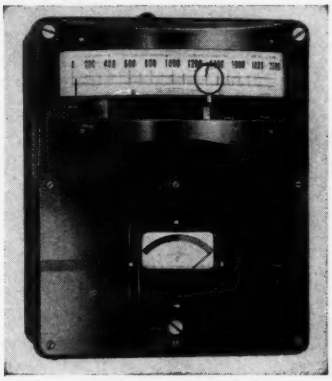
THIS shop view shows an interesting contrast in size between two Elliott vertical deaerating feedwater heaters. The unit at the left is 12 ft. in diameter, and the overall height is 27 ft. and is rated 378,400 lb. per hr. It is built of copper-bearing steel and includes 100,000 lb. of water storage. This heater is provided with two vent condensers. Normal operation is with both but a single vent condenser is used for partial loads. It was built for the Pennsylvania Power & Light Co., Cedar Steam Electric Station, Harrisburg, Pa.



The deaerating heater at the right is 6 ft. in diameter and 14 ft. 8½ in. high. Standard water storage is provided. The loops in the piping between heater and vent condenser were used because space limitation necessitated installation of the unit with the vent condenser extending through the floor above the deaerating heater. With the vent condenser at this added height, loop seals must be used to prevent breaking of water column which would cause water hammer.

Electronic Pyrometer Controller

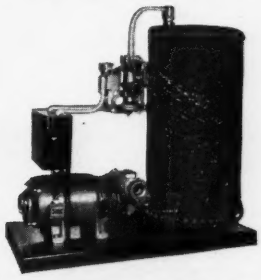
A NEW Electronic Pyrometer Controller has been developed recently by The Bristol Co., Waterbury, Conn. The pointer of the Weston millivoltmeter movement is not engaged or retarded at any point within its normal operating range, thereby leaving it free to continuously indicate the temperature under control. This measuring unit is equipped



with a cold-end compensator. Control is accomplished by means of a new electronic circuit, using a single high-output vacuum tube of the all-metal type. A milliammeter on the front of the instrument indicates the condition of the control circuit at all times. Due to the Bristol's Millivac Relay, the controller is extremely sensitive to changes in temperature at the thermocouple. The entire operating mechanism of this relay is totally enclosed in a vacuum.

Pressure Equalizing Pump

THE JOHNSON CORP., Three Rivers, Michigan, makers of the pressure equalizers, announce that three sizes of its pump are now available with pressure tanks. These tanks are made in cylin-

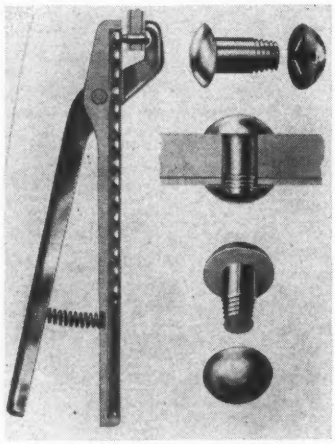


drical shape, of heavy, tough, steel plate. All seams are strongly riveted. The three sizes of the pump available include—No. 100SH, No. 150SH and the new No. 250SH. All three are suitable for pressure up to 125-lb. and are rated to serve boilers of 100, 150 and 250 hp.

POWERLOX, made by Powerlox Mfg. Co., 507 Fifth Ave., New York, New York, is a synthetic leather paste which covers the pulley in a way to impart an unique flexibility to insure perfect frictional grip between pulley and belt. After drying it is impervious to the action of oil, grease, chemical acid gases, frost, dust and heat.

Spring Locking Button

DEVELOPED and patented by David Hoppenstand, president of Hopkan Rivet Co., 128-130 Latham St., Pittsburgh, Pa., this spring locking button can be used in the same places as the present speed nuts and screws. It is so designed that it will not loosen from vibration when assembled. The fastener stud has a head



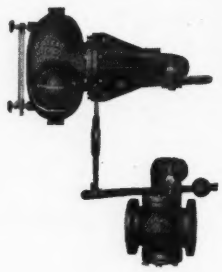
and a shank; the shank being tapered toward the end. The button cooperates with the tapered grooved end of the shank and is provided with inwardly extended spring in locking lugs. The fastener is compressed in the spring locking button which is made of thin sheet steel.

Steel Valve

THE HANCOCK VALVE DIVISION of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces a new 600-lb. standard steel valve available in sizes ¼ to 1 in. inclusive, in the globe type, with either screwed or socket welding ends. This new valve is called the Hancock Duravalve Junior. The seat is Stellite welded integral to the body and eliminates any chance of leakage between seat ring and body. The valve disc is also heavily Stellited to resist wire-drawing and wear. It has a body and bonnet of Carbon Molybdenum steel giving it a temperature rating of 950 deg. at 600 lb. steam pressure.

Liquid Level Controller

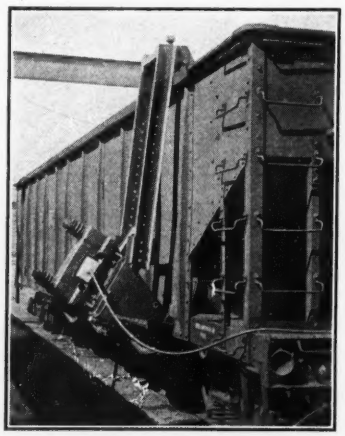
THE MCALEAR MFG. CO., 1901-1907 S. Western Ave., Chicago, Ill., is offering a ball bearing liquid level controller with a balanced lever valve. This assembly is recommended as a continuous drainer to handle large volumes of condensate from vessels. Friction-free, stainless steel ball bearings, mounted in both ends of a substantial yoke, permit the shaft to rotate



freely in its proper position and to take up all internal pressure thrust. A grease seal stuffing box is furnished which permits the use of a stick grease lubricator to keep the packing pliable and to prevent friction on the shaft. The yoke and shaft of the balanced lever valve is similarly equipped. The controller and valve are made for a maximum working pressure of 600 lb. at 750 deg. F. The valves come in sizes up to 8 in., inclusive.

Vibrator

SYNTRON CO., 494 N. Lexington Ave., Homer City, Pa., has just developed a new, large vibrator. fitted with hooks for attaching to hopper bottomed railroad cars to speed up the emptying process. The vibrators are huge pulsating electro-magnets striking 3600 times per minute and together with the hook weigh 950 lb. each. They are also designed to



be used, without the car hook, on big bunkers and storage bins to promote a free flowing discharge of material. Each vibrator comes with a separate electrical control panel that contains a thermionic valve for changing alternating current to pulsating current, operating switches and a variable resistance for controlling the vibrator's amplitude of power. This equipment is designed for operation on 220 volt, single phase, alternating current.

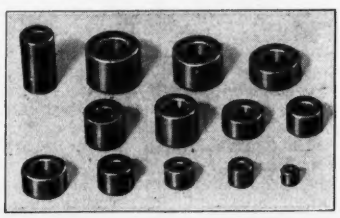
Zone Control System

THIS system employs the T14A Weatherstat as its master which is mounted outside the building on the outer wall of the zone it is to control and functions like a miniature building in that it has its own thermostat and heating plant, the latter in the form of an electric heating coil. This system provides for the continuous flow of steam

during lower outdoor temperatures and for two position operation of the Modulating Motorized Valve during higher outdoor temperatures. It is designed to control single or multiple zone jobs with each zone having a separate control panel. The system is applicable to two-pipe steam heating systems only, and cannot be applied to one-pipe systems. Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., is the manufacturer.

Motor Shunt Beads

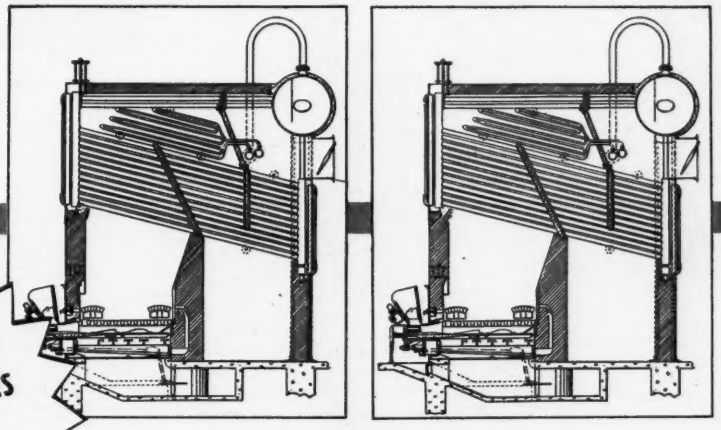
A NEW glazed ceramic motor shunt head, announced by the American Lava Corp., Chattanooga, Tenn., is made of A1SiMag and has the same high mechanical strength, density and electrical



resistance, even at elevated temperatures, that has proven so satisfactory for the most exacting insulation requirements. An outstanding feature is the perfectly smooth inside area which is lubricated by a glazed coating.

QUACHROM GLUCOSATE, a new organic chromium inhibitor announced by D. W. Haering & Co., Inc., Chicago, Ill., applied in both liquid and vapor phases controls both oxidation and sulphide types of corrosion. Ten pounds of this chemical are used to treat 1000 cu. ft. of salt brine. Quachrom Glucosate forms a monomolecular oxidation film which protects metal surfaces from corrosive attack. This film is resistant and self repairing offering a maximum of corrosion protection with a minimum of control.

Why did tubes burn out in one "identical twin" boiler and not in the other?



A TRUE STORY FROM THE FILES OF HALL LABORATORIES

THIS is a story of supposedly twin boilers which in action proved to be anything but identical. They are in a plant which operates with 97% condensate returns and 3% zeolite make-up. For convenience, we label them boiler A and boiler B.

A turbine strainer plugged and the superheater tubes of boiler A burned out. Engineers of Hall Laboratories were called in. Their diagnosis was carryover.

They were right because when boiler B was put back in operation carryover was clearly in evidence. This could be accounted for by the boiler water because it contained unduly high total solids, alkalinity and organic contamination.

After better control of blowdown was instituted and normal protective conditions were established in the boiler water by the use of alkali-reducing Hagan phosphate, Santosite and Hagan dispersive tannin, *carryover from boiler B stopped!*

It looked as if the problem of the twin boilers had been solved, until—

Boiler A, equipped with new superheater tubes, was put back on the line. Although boiler water conditions were the same as in boiler B, pressure drop through the new superheater increased greatly in only two months. Then the tubes failed again—not by deformation but by pitting.

Again Hall engineers found the cause as carryover. Analysis of the two types of deposit found in the superheater showed residue from evaporated boiler water, and crystalline magnetic iron oxide. It was evident that the corrosion had been caused by concentrating caustic boiler water in the superheater tubes.

The cause of the carryover this time was not chemical but mechanical.

After numerous small leaks in the internal steam-drum baffle had been stopped, the trouble ended. Boiler A at last became the "identical twin" of boiler B.

Correct diagnoses like these don't just happen. They are possible only with the highest form of skill, years of intensive training and specialization. Hall engineers, in cooperation with plant engineers, reach these objectives constantly.

On the words of thousands of plant operators you can entrust your most difficult water-conditioning problems to us with confidence.

HALL LABORATORIES, INC. · 300 ROSS STREET · PITTSBURGH, PA.

HALL SYSTEM *of Boiler Water Conditioning*

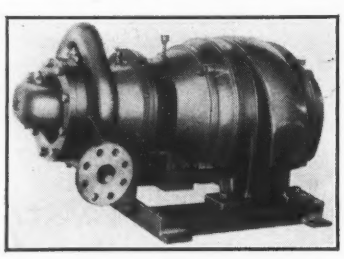
Vertical Single Phase Motor

FAIRBANKS, MORSE & CO., Chicago, Ill., recently announced a line of small horsepower vertical single phase motors in sizes from ¾ to 5 hp. which is adaptable to operate in isolated localities where small pumping units are so often located. Solid or hollow shaft modifications can be furnished. The solid shaft units are usually direct-connected to a pump or machine through a flexible coupling. The hollow shaft unit is adapted to vertical pump applications. Operating speeds are 1200, 1800 and 3600 r.p.m. All 1800 r.p.m.

and lower speed motors are built in the repulsion-start induction-run type. The 3600 r.p.m. ratings differ slightly since they do not require a short circuiting device in the armature. They start as a repulsion motor and as the speed rises the deeply imbedded squirrel-cage winding in the rotor picks up a large portion of the load automatically in much the same manner as does the inner winding of a double-squirrel-cage rotor in a polyphase motor. All coil windings are repeatedly dipped and baked to saturate the protective covering on the wire. The insulating material used in this process is a heavy-bodied, permanently-pliable compound selected for its moisture, oil and acid resisting qualities.

Multi-Stage Unit Pump

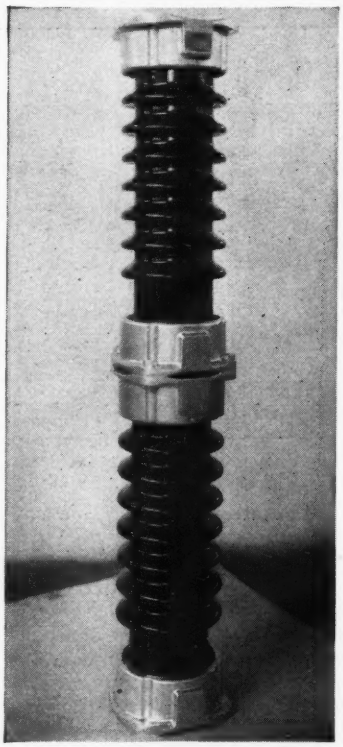
ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has recently extended its line of multi-stage "SSUnit" pumps in which the motor and pump housings are bolted together for compactness. This includes a new two stage pump with 4 in. suction and 2 in. discharge that can be rated up to 275 g.p.m. against heads up to 500 ft. at a speed of 3550 r.p.m. The new pump has cast iron casing and cover, and is bronze fitted throughout. The impellers



are placed back to back to provide axial balance. The cover can be readily taken off, permitting the inside parts to be removed without disconnecting the suction and discharge piping. The stuffing box on the pump is only subjected to suction pressure.

Lightning Arresters

A NEW line of Type "LV" unit design lightning arresters covering the range from 20-kv. to 73-kv., and designed primarily for the small substation has been announced by the Westinghouse Electric & Mfg. Co. Complete arrester units 20, 25, 30, and 37 kv. consist of 3-in. diameter porous-block elements, and a multiple series gap of resistance type spacers, and metal electrodes. Entire assembly is encased in wet process porcelain, hermetically sealed.



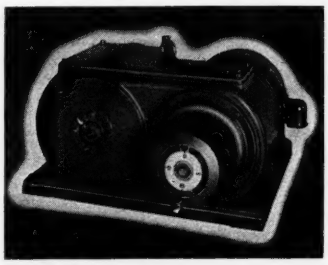
Following unit design practice, units above 37-kv. consist of combinations of two single units: for instance a 40-kv. arrester would consist of two 20-kv. units, etc. The two units combine to form one integral arrester.

Features include absolute moisture proofing, brought about by the solder hermetical seal at each end casting. Greatest improvement is in protective ability against lightning, every arrester being guaranteed to discharge at least 65,000 surge amperes on a 5-10 micro-second wave. Gap breakdown is uniform and stabilized by the resistance type spacers and metal electrodes. To insure their handling "long-tail wave" lightning, and freedom from radio interference each arrester is tested in the laboratory under rated power voltage.

Self-supporting, they may be mounted directly on transformers, or other equipment. Where small clearances prohibit this, mounting brackets may be used and are obtainable.

Handwheel Speed Indicator

REEVES PULLEY CO., Columbus, Ind., announces a new, improved type of handwheel-speed indicator for use with the Reeves Variable Speed Transmission, vari-speed motor pulley and motodrive. This equipment, known as the Speedial indicates speed settings of the different units. The actual indication is a definite number of turns of the speed shifting



screw of the unit. While the standard Speedial is calibrated in turns of the shifting screw, space is available on the dual for the user to write, in pen or pencil, his own calibrations. Blank dials can also be calibrated to the user's individual requirements. Dials may be provided to read either clockwise or counterclockwise. Depending upon the speed ratio of the unit with which the Speedial is to be used, gear ratios of 20:1, 30:1 and 60:1 are available.

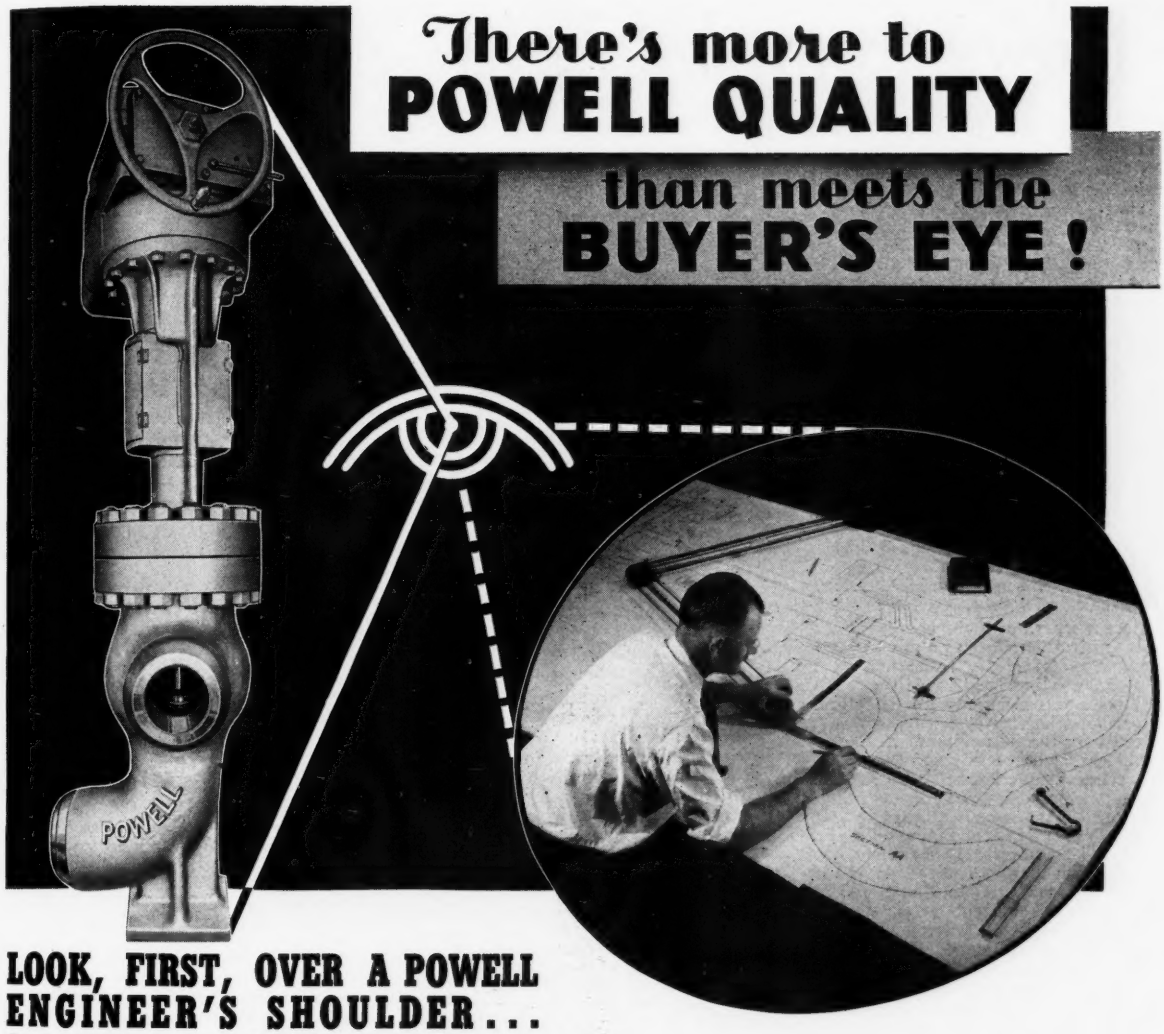
Pipeline Covering

"PYRALIN" cellulose nitrate plastic produced by Du Pont's Plastic Department at Arlington, N. J., for the prevention of pipeline corrosion, is not appreciably affected when exposed to damp atmospheres or immersed in water, is only slightly affected by weak acids and weak alkalies, and has the required rigidity yet is pliable enough to permit easy application. "Pyralin" also remains smooth and hard when underground.

The material is supplied in 0.010 in. thickness in rolls approximately 8½ in. wide, about 45 lineal feet and weighing approximately 2¼ lb. to the roll. The price is 75c per pound net, f.o.b. factory at Arlington, N. J.

Pyralin is wrapped around the pipe, spirally, by hand; a lap of about ¾ in. cemented by applying a solvent with an ordinary hand brush to the edge of the stock during the winding operation. Du Pont No. 231 cement, priced at $3.50 per gal. net, has been found very suitable for this purpose. The iron pipe is first painted with an ordinary primer coat, then covered with an application of asphalt, around which the Pyralin is finally wound to make the permanent protective coating.

There's more to POWELL QUALITY than meets the BUYER'S EYE!



LOOK, FIRST, OVER A POWELL ENGINEER'S SHOULDER...

for assurance of increased valve efficiency and prolonged service life

Nowhere are the *hidden* qualities of Powell valves more readily apparent than in our engineering department. Here the "specifications" for Powell performance are constantly being "rewritten" to include changes in design and construction which have demonstrated their ability to increase the operating efficiency of the valve and prolong its life.

Your eye, for instance, may not recognize the refinement of internal design which distinguishes Powell valves and assures a freer flow of the medium being handled. But this important feature guards against needless pressure drop in the line, thereby saving you many times the cost of the valve in power, or other energy, which you might otherwise waste.

Yes, there's a *lot* more to Powell quality than meets the eye . . . and the importance of this inherent superiority cannot be overemphasized. Won't you make it a primary consideration in the selection of valves for your requirements?

POWELL VALVES

THE WM. POWELL COMPANY • CINCINNATI, OHIO

You Need More Than a Photograph of the Finished Product to See ALL of the Qualities that Make Powell Valves Uniquely Able to Better Serve the Power Engineer

News from the Field

ALREADY, more than six months in advance of the 14th National Exposition of Power & Mechanical Engineering, which will be held at Grand Central Palace, New York, December 2 to 7, nearly 250 leading concerns have engaged exhibit space. With normal business improvements being stimulated by foreign orders and the national defense program, there should be great buyer interest.

Attendance is limited by personal registration and is confined to those executives, engineers and operating men who are interested in equipment for the generation, distribution and utilization of power. Analysis of the registrations at the last Exposition in 1938 shows 42,661 attendance, with 9,068 technical engineers (mechanical, consulting, marine, electrical, civil, etc.) 2,393 chief and plant engineers, 302 plant managers, 1,369 superintendents, 1,630 foremen, etc. This 14th National Power Show is managed by International Exposition Co., Charles F. Roth president, with headquarters at Grand Central Palace, New York.

AT A MEETING of the board of directors of Northern States Power Co., the resignation of Henry Grenacher, as director, was accepted and George C. Mathews was elected to fill the vacancy created. The following officers were elected for the ensuing year: R. F. Pack, president and general manager; T. D. Crocker, vice president; H. C. Cummins, vice president in charge of operation; George C. Mathews, vice president and controller; J. J. Molyneaux, vice-president and treasurer; H. E. Young, vice-president in charge of sales; M. A. Morrison, secretary; R. L. Clark, assistant treasurer and assistant secretary; P. A. Lahmkuhl, assistant treasurer; J. J. Madden, assistant secretary; E. G. Kellett, assistant secretary.

THE UNITED STATES CIVIL SERVICE COMMISSION has announced an open competitive examination to secure ordnance draftsmen for the War and Navy Departments. Applications will be accepted at the Commission's Washington office until June 30, 1941. If sufficient eligibles are obtained before this date the receipt of applications may be closed, in which case due notice will be given.

Applicants must have had certain high-school study, except that they may substitute drafting experience, in addition to that required for each grade, for this requirement. In addition applicants must have had certain elementary drafting training or experience, and certain ordnance drafting experience, consistent in quality with the grade applied for. Full information as to the requirements for this examination, and application forms, may be obtained from the Secretary of the Board of U. S. Civil Service Examiners at any first or second class post office, or from the U. S. Civil Service Commission, Washington, D. C.

FOR HIS many achievements in the advancement of engineering education and its application to industry, Dr. Audrey Abraham Potter was honored with the award of the Lamme Medal for 1940 by the Society for the Promotion of Engineering Education. Now presented for the thirteenth time, the Lamme Medal honors the memory of Benjamin G. Lamme, a pioneer in engineering development of electric power. Presentation of the award was made by Prof. Herbert B. Langille of the University of California.

THE UNITED STATES CIVIL SERVICE COMMISSION has announced examinations to fill engineering positions in the Government in various specialized fields. Salaries range from $2,600 to $4,600 a year, less a retirement deduction of 3½ percent. Applications must be filed with the Commission's Washington office not later than August 5 if received from States east of Colorado, and not later than August 8, 1940, if received from Colorado and States westward. Applicants must have had study in an engineering course in a recognized college, and professional engineering experience in the branch of engineering for which application is made. Applicants will not be given a written test, but will be rated on their qualifications as shown in their applications and on corroborative evidence. Full information as to the requirements for the examinations, and the appropriate application forms, may be obtained from the Secretary of the Board of U. S. Civil Service Examiners, at any first- or second-class post office, or from the U. S. Civil Service Commission, Washington, D. C.

LIEUTENANT A. ERNEST THOMAS has been elected president of the Greater New York Association No. 1, National Association of Power Engineers of America. He is Supervising Engineer of The Dime Savings Bank of Brooklyn and has been employed in that capacity since 1932. The Greater New York Association No. 1, chartered in 1882, numbers more than 700 active members in the metropolitan area. Officers for the ensuing year are: President, A. Ernest Thomas, who succeeded Fred J. Koster; Vice-president, William Wrightson; Treasurer, Fritz Schultz; Corresponding Secretary, Harry Waite; Financial Secretary, James Negley.

IT HAS been announced that the Refrigerating Machinery Association and the Air Conditioning Manufacturers' Association have been combined under the name of Air Conditioning and Refrigerating Machinery Association with offices in the Southern Building, Washington, D. C.

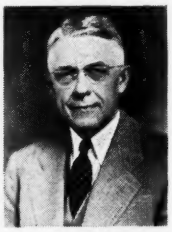
W. C. MORGENSTERN is now Assistant Chief Engineer at Copperweld Steel Co.'s new steel plant at Warren, Ohio. He is a graduate of Cornell University.

THE ANNUAL CONVENTION and Iron and Steel Exposition of the Association of Iron and Steel Engineers will be held in the Stevens Hotel, Chicago, Illinois, September 24, 25, 26 and 27, 1940. The technical program should prove to be one of the most interesting in recent years and the following subjects will be discussed: High Voltage Air Circuit Breakers; Modern Electric Furnace Design and Practice; Mercury Arc Rectifiers for Main Roll Drives; Design and Operation of Gear Drives; Diesel Shifting Equipment in the Steel Plant; Maintenance Shops in the Steel Plant; Welded Construction of Blast Furnace Stoves; Welded Open Hearth Auxiliaries; Building-up and Hard Surfacing; Effect of Soaking Pit Operation on Steel Conditioning; Comparison of Soaking Pit Designs; Soaking Pit Control; Composition Bearing for Roll Necks; Hot Scarfing of Billets, Blooms, and Slabs; Design and Operation of Continuous Butt-Weld Pipe Mills; Reversing Drives for Slabbing Mills; Power Requirements for Hot Strip Mills; Hot Strip Coilers and Their Drives; A Survey of Open Hearth Design; Relation of Flame Characteristics to Open Hearth Operation; Open Hearth Furnace Control; Developments in Blast Furnace Has Cleaning; Rehabilitation of Blast Furnaces; Factors Affecting Production of Blast Furnace Gas; Composition and Manufacture of Grease Lubricants; Lubrication and Its Relation to Maintenance; and Application and Care of Bearings in the Steel Plant.

THE ADDRESS of the Solid Fuel Institute has been changed to 740 N. Plankinton Avenue, Milwaukee, Wis.

Gaylord A. Freeman

ACCORDING to an announcement by Chairman Charles Y. Freeman, Gaylord A. Freeman has been elected vice-president of Commonwealth Edison Co. in charge of sales. He fills the vacancy caused by the death of Edward W. Lloyd on June 26. He has spent his entire business career in the service of the Chicago utility company, starting in the statistical department in 1901, and later becoming secretary to the chief mechanical engineer secretary to the vice-president in charge of engineering and construction and chief clerk of the company with supervision over miscellaneous activities including telephone service, fire insurance and billing of wiring work.



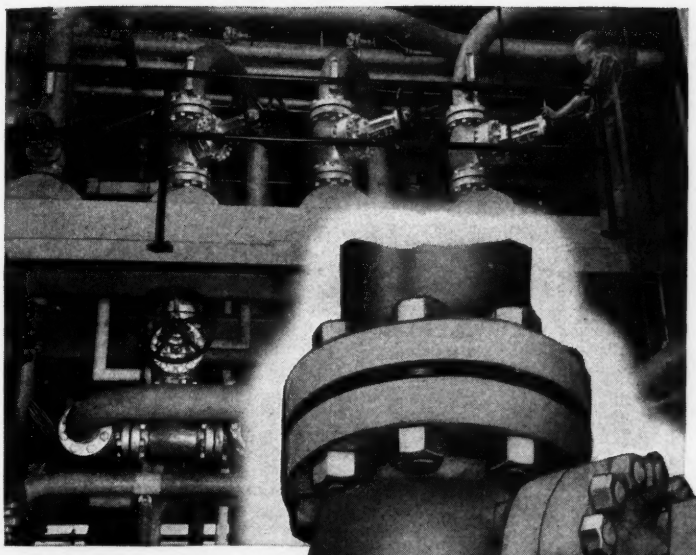
Gaylord A. Freeman

In 1933 he headed the air conditioning promotion program, and three years later was appointed assistant manager of industrial relations. In a short time he became manager of industrial relations and director of public relations and in 1937 was named assistant to vice-president. He was born in Mount Vernon, Ohio, and is 57 years of age.

Dr. Sorensen Heads A.I.E.E.

DR. R. W. SORENSEN, Professor of Electrical Engineering and Head of the Department of Electrical Engineering, California Institute of Technology, Pasadena, Calif., was elected President of the American Institute of Electrical Engineers for the year beginning August 1, 1940, as announced at the annual meeting of the Institute held in Swampscott, Mass., during the summer convention of the Institute. The other officers elected were: Vice-Presidents Everett S. Lee, Schenectady, N. Y.; J. W. Barker, New York, N. Y.; K. L. Hansen, Milwaukee, Wis.; J. L. Hamilton, St. Louis, Mo.; A. LeRoy Taylor, Salt Lake City, Utah—Directors T. F. Barton, New York, N. Y.; M. S. Coover, Ames, Iowa; R. G. Warner, New Haven, Conn.—National Treasurer W. I. Slichter, New York, N. Y. (re-elected).

These officers together with the following hold-over officers will constitute the Board of Directors for the next administrative year, beginning August 1, 1940: F. Malcolm Farmer (retiring



Another Power Plant—a Public Utility plant—uses Reading-Pratt & Cady Steel Valves throughout in its drive for lower KW Production Costs.

Illustrated is Reading-Pratt & Cady's Fig. 9001-D 900 lb. Cast Carbon Molybdenum Steel, 12/14 Stainless Steel Trim, Gate Valve used on the main feed water lines of the modernized utilities steam power plant shown above.

Cooperating with hydro...

This public utilities steam power plant operates as a part of a steam and hydro system. Low KW costs are imperative—and the cost of such items as valve maintenance is given serious consideration.

Naturally it is gratifying to us that this utility approved and installed Reading-Pratt & Cady valves in its modern steam power plant and we would like to offer this as further indication that you, too, would find our recommendations for valves made with your problems very much in mind. Write us whenever valves are up for discussion.

READING-PRATT & CADY
DIVISION · · READING, PENNSYLVANIA

AMERICAN CHAIN & CABLE COMPANY, Inc.

President), New York, N. Y.; C. R. Beardsley, New York, N. Y.; V. Bush, Washington, D. C.; M. Eldredge, Memphis, Tenn.; R. E. Hellmund, East Pittsburgh, Pa.; H. W. Hitchcock, Los Angeles, Calif.; F. H. Lane, Chicago, Ill.; L. R. Mapes, Chicago, Ill.; F. R. Maxwell, Jr., University, Ala.; F. J. Meyer, Oklahoma City, Okla.; H. S. Osborne, New York, N. Y.; John C. Parker, New York, N. Y.; D. C. Prince, Schenectady, N. Y.; C. T. Sinclair, Pittsburgh, Pa.; J. M. Thomson, Toronto, Ontario, Canada; A. L. Turner, Omaha, Neb.

The annual report of the Board of Directors, presented at the meeting showed a total membership on April 30, 1940, of 17,213. In addition to two national conventions and three District meetings, 2,047 meetings were held during the year by the local organizations of the Institute in the principal cities and educational institutions in the United States, Canada, and Mexico.

Edward W. Lloyd

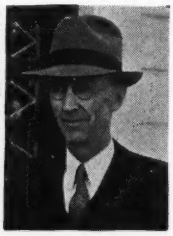
Edward W. Lloyd

EDWARD W. LLOYD, vice-president in charge of sales for Commonwealth Edison Co., Chicago, died on June 26 at the age of 68. He had been in ill health for several months. He was president of the National Electric Light Association in 1915-16 and headed several important committees in that organization and the Edison Electric Institute which succeeded it.

Born in Belleville, Ontario, on February 3, 1872, in 1880 his family moved to Erie, Pa. Coming to Chicago in 1892, he entered the employ of the then Chicago Edison Co. He became a construction foreman in 1898 and four years later was elevated to Assistant Superintendent of Construction. In 1906 he was appointed general contract agent and in 1926 was elected vice-president of Commonwealth Edison Co.

He is survived by his widow, Alice Scott Lloyd, a daughter, Mrs. Philip A. Starck, a son, Allen G. Lloyd, and a brother, Arthur M. Lloyd, who is supervisor, commercial cooking appliances, for Commonwealth Edison Co.

Sinclair O. Harper



Sinclair O. Harper

SINCLAIR O. HARPER, Assistant Chief Engineer in the Denver office of the Bureau of Reclamation since 1930 has been appointed Chief Engineer. He has been Acting Chief Engineer since the death of Raymond F. Walter and has been with the Bureau for 33 yr. during which time he has gained a thorough knowledge of irrigation construction.

Manufacturers' News

TRIMOUNT INSTRUMENT, INC., 332 South La Salle St., Chicago, Ill., announces that Gene Kreml has been promoted to the position of Assistant Chief Engineer. He was formerly at the Hawthorne Works of the Western Electric Co.

AFTER an illness of six weeks, William Spencer Ralston, president of the Chaplin-Fulton Manufacturing Co., died on July 3, at the age of 70 years. He had been connected with the Chaplin-Fulton Co. for nearly 40 years and more recently president of the company, of which his father, David A. Ralston, was one of the founders. He is survived by his wife, Jane Gleason Ralston; a daughter, Mrs. Ford E. Curtis; two grandchildren, and a sister, Mrs. William Ruess of Philadelphia.

BRADSHAW & Co., 530 Fourth Avenue, Pittsburgh, Pa., Sales Engineers in the Pittsburgh district for a variety of boiler plant equipment, announces the entrance into their organization of Tom H. Jones, formerly of Cleveland, Ohio.

THE PITTSBURGH OFFICE of Cutler-Hammer has been moved to new and larger quarters. According to T. S. Towle, manager of the territory, the new location is in the Park Building at 355—5th Avenue.

LACLEDE STOKER CO., St. Louis, Mo., announces the appointment of Loyd R. Stowe, 308 W. Washington St., Chicago, Ill., as representative in the Chicago territory.

EDWARD N. CORNING, Sales Engineer of the Everlasting Valve Co., Jersey City, N. J., died on July 6.

ACCORDING to an announcement by H. H. Barnes, Jr., commercial vice-president of the General Electric Co., George Campbell has been appointed manager of the Buffalo office. He succeeds George H. Calkins, who retired July 1 after more than 41 years of service with the General Electric Co. Also announced are the appointments of Ralph M. Darrin as manager of the Syracuse office, E. H. Aussicker of Binghamton as manager of the Schenectady local office, and E. B. Currie as manager of the Binghamton office.

THE MEDART CO. has purchased the entire wood pulley stock of the Reeves Pulley Co., which has discontinued the manufacturing and marketing of wood split pulleys. The Medart Co. will continue to serve all of the wood pulley dealers and customers of the Reeves Pulley Co. as well as Medart dealers and customers.

ALBERT KAHN, INC., announces the formation of a new corporation in which the former employees having 25 years service are now stockholders. The new firm will be known as Albert Kahn Associated Architects and Engineers, Inc. All future commissions will be undertaken by the new corporation.

THE C. O. BARLETT & SNOW CO., Cleveland, Ohio, has announced the appointment of C. O. Bartlett as District Manager in the Detroit territory. He is the son of the founder and organizer of the company and has been a director for the last 20 yr.

CHARLES H. KRAFT, president of the Callite Tungsten Corp., Union City, N. J., announces the acquisition of Harris Alloys, Inc., by his company, to be conducted as a division of and under the corporate name of the Callite Tungsten Corp. Frederick T. Harris, former Harris executive head, will have full charge of operations of this new division, with sales activities under the supervision of D. R. Donovan, general sales manager, of the Callite Tungsten Corp. Callite will add to its regular list of products a line of special wires in sizes down to 0.001 in., including aluminum, stainless steels, nickel silver, everdur, brass in all grades, brush wire, commercial bronze, phosphor bronze and fourdriniering, silver, monel.

THE BOARD OF DIRECTORS of The Norton Co. announces the election of Harry K. Clark to the office of vice-president and general manager, and Andrew B. Holmstrom to the office of vice-president and works manager. These appointments were to fill vacancies caused by two resignations. Aldus C. Higgins, president, who also held the office of general manager, resigned the general managership, and George N. Jeppson, treasurer and vice-president, who also held the position of works manager, resigned from the office of works manager. Mr. Higgins will retain the office of president and Mr. Jeppson will retain the offices of treasurer and vice-president.

HARRY T. SMITH, Traffic Manager of Worthington Pump and Machinery Corp., died at his home on July 3. He had been associated with the company 54 years.

THE WINDSOR STATION, Power, W. Va., is owned by the West Penn Power Co. and the Ohio Power Co. The latter in 1937 topped its half of the plant by the installation of two 750,000 lb. per hr. steam generating units supplying steam at 1250 lb., 925 deg. F. to a 60,000-kw. turbine generator which, in turn, exhausts at 235 lb. to three 30,000-kw. existing turbines. At that time a 60,000-kw. topping turbine generator was ordered by the West Penn Power Co. but installation was defered until May of this year when an order was placed with Combustion Engineering Co. for two high-pressure steam generating units to serve this turbine generator and the other three 30,000-kw. existing low pressure turbines.

These steam generating units will be of the three drum, bent-tube type, designed for an output of 750,000 lb. each and 1525 lb. drum pressure, 925 deg. F. total steam temperature. They will be equipped with Elesco superheaters and economizers, Ljungstrom air preheaters, and each will be served by three C-E Raymond bowl mills. The furnaces will be of the continuous slag-drip type and will be tangentially fired.

TO FURNISH power for its completely mechanized coal mines, the Union Pacific Coal Co. is increasing the capacity of its steam power plant at Rock Springs to 20,000 kw. with the addition of a 7500-kw. General Electric turbine generator. Full rating of the new G-E steam turbine will be 7500 kw., 0.8 p.f., 3 phase, 60 cycle, 2400 v. at 3600 r.p.m. Steam conditions will be 400 lb. gage, 700 deg. F. total temperature, and 1½ in. absolute. The unit will be equipped with a direct-connected, totally enclosed, stabilized shunt-wound exciter; an electric tachometer; a steamseal regulator; and a speed corrector to obtain adjustment of settled regulation down to and including zero.

NATION'S BANK

PAY A. W. CASH CO. $98.00

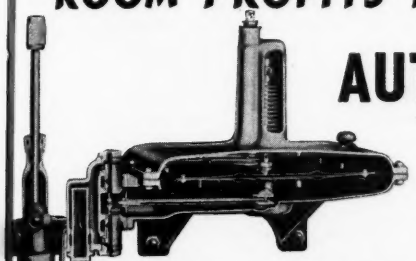
$98 and 00 cts DOLLARS

A PROGRESSIVE MANUFACTURER

★ This cost—$98.—is for the Furnace Draft Controller (see top illustration left of page) which you install first, with a view to later purchasing the complete CASH STANDARD Automatic Combustion Control System.

IF THIS WERE YOUR CHECK . . . YOU WOULD BE PURCHASING AN IMMEDIATE START ON THE BOILER ROOM PROFITS YOU CAN GET WITH

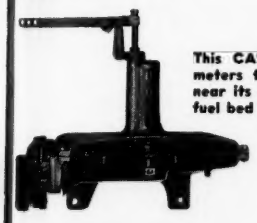
AUTOMATIC COMBUSTION CONTROL



YOU CAN GET THIS FURNACE DRAFT CONTROLLER FOR ONLY $98.00

This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from over-fire draft, regulating the boiler uptake damper, to maintain a constant draft in the combustion chamber. Place it near the up-take damper. It works independently of either of the two Controllers shown below. It does its part toward money saving by eliminating wasteful air infiltration.

ADD THE REST OF THE SYSTEM LATER . . . TO MAKE IT COMPLETE FOR ONE BOILER

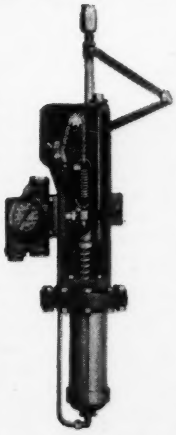


AIR FLOW CONTROLLER

This CASH STANDARD AIR FLOW CONTROLLER meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.

FUEL FEED CONTROLLER

This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion—hence, money saving.



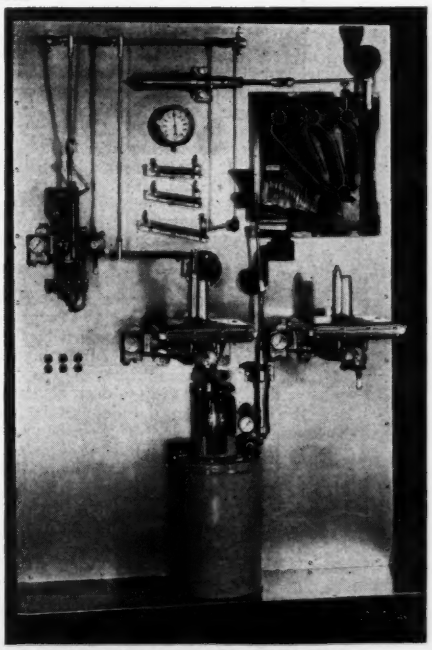
OIL CIRCULATOR

The purchase of this oil circulator is optional. All three Controllers shown above can be properly operated by clean water, but it is preferable and cheapest in the long run to operate this equipment with this CASH STANDARD OIL Circulator, price $108 equipped with 110-220 v. 60 cy. motor.

This is a simple, convenient purchase plan to consider if you are figuring ways and means of getting the many benefits of Automatic Combustion Control without making a large initial expenditure. The Furnace Draft Controller works independently (read about it at left of page), therefore, it is the logical part of the system with which to begin.

You'll find that there is no finer equipment made and that in installations made on this plan you get precisely the same control units that we furnish on the most elaborate kind of job—and for the largest kind of boilers.

The one requirement necessary to make this money-saving plan workable, is that you install the control units conveniently near the apparatus they operate, without panel board.



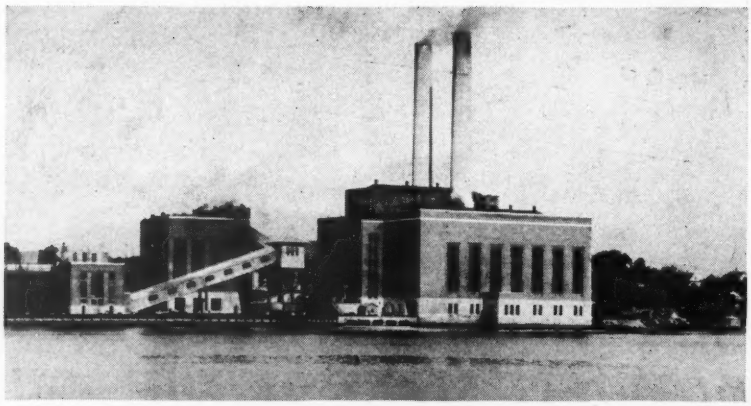
You get Fuel Feed Controller, Air Flow Controller, with Operating Power Cylinders included (as in the Furnace Draft Regulator), and necessary connecting fittings—all for as little as $290. If you want CASH STANDARD Control System on panel boards, you can get them; but we emphasize that the control units work just as well mounted individually elsewhere. Here you see a portable display panel on which full size control units (with miniature boiler) work automatically to show the real sensitivity, accuracy, and dependabiliy of the CASH STANDARD System.

Get the complete facts—write for bulletin 963-A-B.

A. W. CASH COMPANY

DECATUR, ILLINOIS

CASH STANDARD CONTROLS . . VALVES



Somerset Makes the Headlines with Forced Circulation

Announcement of a high-capacity, high-pressure forced circulation steam generating unit for the Montaup Electric Co.'s Somerset Station on the Taunton River near Fall River, Mass., opens a new epoch in American power generation. Designed by Combustion Engineering Co. for 650,000 lb. per hr., 2000 lb. pressure, 960 deg. F., and reheat at 400 lb. to 750 deg. F., the new unit, together with its 25,000 kw. topping turbine, is expected to cut the station heat rate from over 14,000 to somewhere between 10,000-11,000 B.t.u. per kw-hr. The two existing 375 lb. units with a combined capacity of 76,000 kw. are now supplied steam by five boilers, each of which occupies a floor space equivalent to that needed by the new boiler. This new boiler will be tangentially fired with a completely water cooled furnace of the wet bottom type. Pulverized coal from the existing storage system will be used with oil as an alternate fuel. Other features include regenerative air heaters, a reheater, economizers and a convection type superheater designed to give a practically constant steam temperature from full load down to 480,000 lb. per hr. One turbine, one motor and one dual drive circulating pump, any two adequate for full load conditions will be installed. Feed pumps will take their suction from the present 475 lb. pumps and discharge at 2200 lb. to the new boiler. The initial installation at Somerset, with one 32,000 kw. turbine and three 1492 hp. bent tube boilers, was made in 1925. The ultimate capacity of the station was originally intended at 210,000 kw. and the topping unit will bring the gross generating capacity to 101,000 kw.

INDIANAPOLIS POWER AND LIGHT CO. has placed an order with the General Electric Co. for its seventh unit substation. The unit's transformer will be rated 3900/3300 kv-a. at 33000/4330 volts. In the switchgear will be one metering and control power compartment, one transformer breaker compartment, and three feeder breaker compartments. All breakers will be rated 100,000 kv-a.

THE EXTENSION to the boiler room of the Erwin Cotton Mills' No. 1 and No. 4 plants at Durham, N. C., includes boiler replacements costing over $100,000. J. E. Sirrine & Co., Greenville, S. C., has awarded the building contract to Wm. Muirhead Construction Co.

Capacity Addition for Georgia Power Co.

NEXT year the capacity of Plant Atkinson of the Georgia Power Co. at Atlanta, Ga., will be doubled by the addition of a 60,000-kw. G-E turbine. While practically a duplicate of the unit installed in 1930 design improvements made during the last decade will be incorporated. The new turbine with a surface type air cooler will have 17 stages and drive a 66,667-kv-a., 13,800-v., 60-cy., 1800 r.p.m. generator. Steam conditions are 425 lb., 725 deg. F. and two in. abs. back pressure.

Louisville Gas & Electric Co. To Build Plant Addition

THE LOUISVILLE GAS & ELECTRIC CO., Louisville, Ky., has approved plans for new addition to local steam-electric generating station on Canal Street, to increase capacity by 25,000-kw., and will proceed with project at early date. A contract for a steam turbine-generator unit of size noted has been let to Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; an award for high-pressure boiler has been made to Combustion Engineering Corp., New York, N. Y.; and for condenser and accessories, to Ross Heater & Mfg. Co., Buffalo, N. Y. Contracts for other required equipment are scheduled to be made soon. Plant is expected to be completed in 1941. The Utility Engineering & Service Corp., 231 South LaSalle Street. Chicago, Ill., is consulting engineer. This is part of an expansion program to be carried out by company, which also will include a new 33-kv. power transmission line from Louisville to Fort Knox, Ky., about 35 miles.

City Power Plant at Newark, N. J., to be Improved—or Abandoned

THE CITY COMMISSION, Newark, N. J., is considering plans for improvements in the City Hall power plant or the abandonment of the station, as certain Commissioners now propose, following recommendations of an engineer, employed to make a survey. Such survey gives estimated savings of about $25,000 through the use of service from the Public Service Electric & Gas Corp. Vibrations caused through the operation of the plant are held to be damaging the building of the Board of Education, in the immediate vicinity, giving further cause for the elimination of the station. On the other hand, a report has been submitted by Orrok, Myers & Shoudy Associates, 21 East Fortieth Street, New York, consulting engineers, making three recommendations for the retention of the plant, and which proposals are under advisement. These cover (1) installation of steam turbine units at estimated cost of $44,000; (2) reduction in operating costs by one engineer and three firemen; and (3) installation of a complete automatic oil-burning heating system to cover present plant requirements at estimated cost of $32,660 and the use of central station for operation. With the latter plan, it is estimated that the saving in present cost would be $27,821 per year. An early decision will be made.

Tennessee Valley Authority Proposes $65,000,000 Expansion

THE TENNESSEE VALLEY AUTHORITY, Knoxville, Tenn., is planning for further power development to cost about $65,000,000, and a measure for an appropriation of that amount is now being considered by Congress, with proposal that an immediate fund of $25,000,000 be made available for proceeding with the program. The project has been approved by the National Defense Advisory Commission as essential to meet power requirements for the production of war materials plants now located and to be constructed later in the TVA area. The work will include a new hydroelectric generating station on the Holston River, near Jefferson City, Tenn., at site to be known as Cherokee Dam, approximately 35 miles from Knoxville, to include new power dam, reservoir and generating plant with initial capacity of 90,000-kw. With switching station and transmission lines for connection with present system, this development is estimated to cost about $36,000,000; additional generating units are proposed at the present Wilson Dam and Pickwick Dam hydroelectric power plants, at estimated cost of $5,500,000; a third feature of the program is a new steam-electric generating plant near Nashville, Tenn., to be used for auxiliary service, with steam turbine-generators and high-pressure boilers for a capacity of 120,000-kw., estimated to cost approximately $10,500,000. The remainder of the proposed appropriation, $14,000,000, will be used for extensions in transmission lines, power substations and switching stations, and other operating structures.

Potomac Electric Power Co. Authorizes Further Plant Expansion

THE POTOMAC ELECTRIC POWER CO., Washington, D. C., has approved plans for further expansion at Buzzard's Point steam-electric generating station, where work is now in progress on new addition, following authorization a few months ago. The present development provides for the installation of a new 50,000-kw. steam-turbine generating unit, high-pressure boilers and auxiliaries, with completion scheduled next October. The additional expansion will provide for another generating unit of the same capacity, with additional boiler and miscellaneous equipment; awards for main equipment are being made, to be followed by orders for other required equipment in near future. Company is arranging for a bond issue of $10,000,000. of which about $6,300,000 will be used for the plant expansion, as well as for

Two Vogt Boilers

BURN 230 TONS *LESS* COAL

AND *INCREASE* POWER 88%

at the
MUNICIPAL LIGHT
AND WATER UTILITY
Richland Center,
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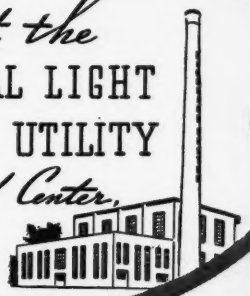

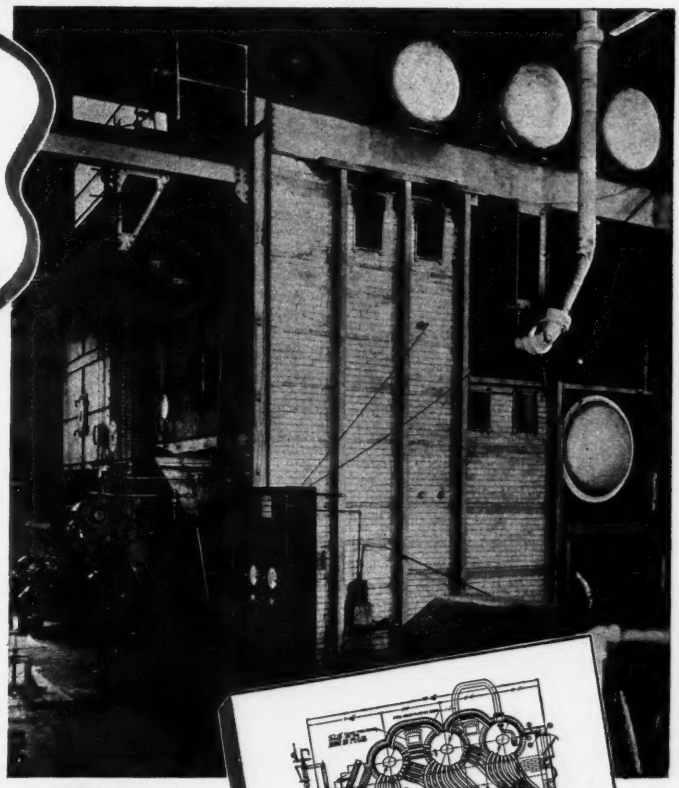

THIS modernly equipped plant, served by two Vogt, four-drum, bent tube boilers, provides dependable, low-cost service the year around for the city of Richland Center, Wisconsin.

A comparison was recently made of the 1939 power output with that of 1935, when boilers of another type, now replaced by the Vogt units, were in service. Plant records revealed that in 1939 a total of 230 tons LESS coal were burned while 2,188,160 MORE K.W. hours were generated than in 1935; a *decrease* in coal consumption and a power *increase* of 88 per cent!

Economize through modernization—Consult Vogt engineers on your steam generating problem!

HENRY VOGT MACHINE CO.
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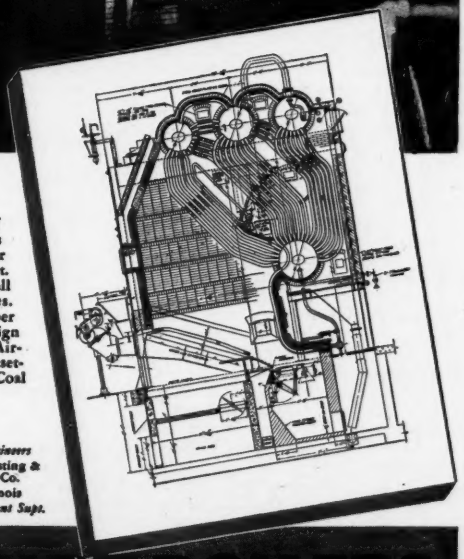
Each unit has 4,197 sq. ft. of heating surface and generates 35,300 pounds steam per hour with 115 deg. superheat. * Water cooled bridge wall with Vogt armored tubes. * 225 pounds per square inch design pressure. * Air-cooled boiler setting. * Fuel—Coal screenings.

Consulting Engineers
Commercial Testing & Engineering Co.
Chicago, Illinois
R. H. Strang, *Plant Supt.*



Vogt WATER TUBE BOILERS
BENT TUBE · SECTIONAL HEADER · BOILERMAKER TYPE

extensions in switchyard structure, switching facilities, transmission and distributing lines. Company is a unit of the North American Co., New York, N. Y.

Nantahala Power Co. Awards Contracts for Hydroelectric Power Plants

THE NANTAHALA POWER CO., Franklin, N. C., has awarded contracts for the construction of two hydroelectric generating stations, recently referred to in these columns, following approval of the Federal Power Commission for both projects, and further sanction by the Tennessee Valley Authority and the North Carolina Utilities Commission. The Utah Construction Co., 1 Montgomery Street, San Francisco, Calif., has secured the award for station on the Nantahala River, Macon County, N. C., where power dam 260 ft. high and 880 ft. long will be built. This plant will be equipped with hydraulic turbines for initial capacity of 63,000-kv-a. The Morrison-Knudson Co., 319 Broadway, Boise, Idaho, will construct the other hydroelectric station in the vicinity of Glenville, Jackson County, N. C., to be located on the West Fork of the Tuckasegee River. The power dam for this development will be 148 ft. high and approximately 820 ft. long, with plant to be equipped for at rating of 30,000 kv-a. Both streams are tributaries of the Tennessee River. Work on the two projects will be placed in progress at once. The first noted is scheduled for completion in about 24 months, and the Glenville station in approximately 15 months. The project is sponsored by the Aluminum Co. of America, Inc., Pittsburgh, Pa., which operates the Carolina Aluminum Co., Badin, N. C., with the Nantahala Power Co., a subsidiary of the latter. A large part of the power output will be used by the Carolina company and its aluminum properties, with remainder available for distribution to industrial and commercial consumers in company territory.

New Engineering Books

Fuels and Their Utilization. By A. R. Carr and C. W. Selheimer. Published by the Pitman Publishing Corp., 2 West 45th St., New York City. Size 6 by 9 in., 177 pp., cloth bound. Price $2.00.

Various fuels, liquid, gas and solid, used in current practice are discussed from both the theoretical and practical standpoint, using as an example fuel utilization in a steam power plant. Following the introduction there are chapters on Combustion, Classification of Fuels, Manufactured Fuels, Combustion of Coal and Other Solid Fuels, Waste Heat, Calorimetric Determination of Heat Input, Heat Balances, Pyrometry and Water for Industrial Purposes. The book does not go into thermodynamics but the chapter on water and water treatment fits in well with the utilization of fuels due to the fact that during the process of heat transformation the water is changed into steam by heat absorbed in the combustion gases. The final chapter outlines in considerable detail 17 laboratory experiments. The heat balance chapter deals with thermochemistry, boiler computations, producer calculations, on through the complete analysis of boiler heat input and output, which gives a true picture of the efficiency of combustion and utilization. The authors are, respectively, dean of the engineering college and assistant professor of chemical engineering at Wayne University, Detroit, Mich.

Practical Electricity. By Terrell Croft. Revised by George H. Hall. Fourth edition. 701 pp., illustrated. 5½ by 8 in., cloth. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1940. Price $3.00.

If one could have only one book on the general subject of electricity this well-known book by Terrell Croft would be the book to select. No single book of reasonable dimensions that we know of contains such a wealth of information on the practical theory and application of electricity as this volume. The writer has had a copy of the former editions in his desk for years and no book is referred to more often.

Practical Electricity was written for certain definite purposes. Primarily, its object is to present the fundamental facts and theories relating to electricity and its applications in a straightforward, easily understood way for study by any man of little mathematical training, who desires to acquire a working knowledge of the subject. If a man understands arithmetic he should be able to get the "meat" out of this book. Secondarily, the book was designed for college graduates who desire a medium whereby they can, with minimum effort, review, refresh and reconstruct in line with modern theory and practice, their concepts of electric and magnetic phenomena.

The last edition of this book was published in 1932. Since that time, numerous advances have been made in electrical development so that a revision to bring all information up to date became desirable. Mr. Croft, however, was unable to undertake this revision so George Hall was authorized to do so. Much of the basic material has been largely retained with only such adjustment and revision as continued development has made necessary. The section on electron tubes which was added to the last edition was revised and extended although the material in this section does not match the other part of the book in thoroughness. In view of the tremendous importance of the electron tube, it seems that much more space and attention should have been given it. This, however, is not a fundamental criticism of the volume as a whole. For information on electron tubes one need only send 25 cents to the Radio Corporation of America for a tube manual—data of that type is easily available today. On the whole, we cannot recommend this book highly enough and it will repay anybody, no matter what his status in the field, to examine it.

Boiler Feedwater Treatments—Second Edition. By F. J. Matthews. Published by Chemical Publishing Co., Inc., 148 Lafayette St., New York, N. Y. Size 5½ by 8½ in. 379 pages. Price $5.00.

With the present trend in steam plants toward high pressures and temperatures, the question of treatment of boiler feedwater has become one of the most important aspects of efficient steam generation. Divided into five parts, this book covers the entire subject including such topics as natural water supplies, scale formation, corrosion, foaming and priming and analysis and routine testing. The book also contains a comprehensive appendix covering standard solutions, reagents, Clark's Table of hardness, chemical factors, conversion tables and recommended practice.

Theory and Application of Electron Tubes. By Herbert J. Reich. First edition. 670 pages, 512 illustrations; 6 by 9 in., cloth. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1939. Price $5.00.

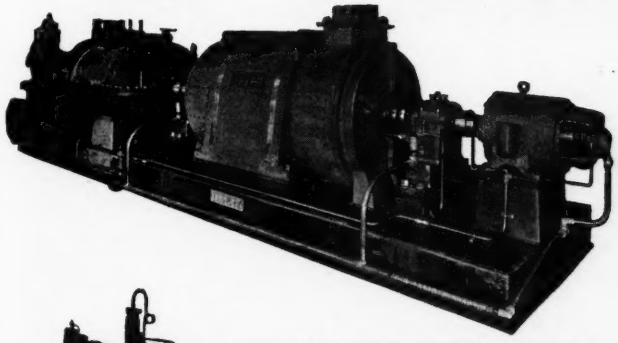
This book meets the need for a single volume to assemble and co-ordinate present knowledge of the theory and application of electron tubes. In view of the continually growing importance of the electron tube as a device useful in industry, there is need for books which explain electronic phenomena in comparatively simple terms which the average electrical engineer can understand. Although this book is somewhat advanced and intended as a textbook for use in colleges at the same time it provides engineers and research workers who have a good electrical background with a thorough, coordinated groundwork in tube and circuit theory to enable them to apply electron tubes to the solution of new problems. The author is Associate Professor of Electrical Engineering at the University of Illinois and the book is based upon mimeographed notes that have been used in his courses on electron tubes during the past five years. The basic principles set forth are applicable to all branches of the art, to industrial and power problems as well as in radio and communication circuits. It presents graphical and analytical methods of studying the characteristics and operation of vacuum tube amplifiers, light sensitive devices and power control circuits. Much practical material is included on the design of voltage and power amplifiers, phototube circuits, power control circuits, power supplies and measuring instruments.

Steam Power Stations. By Gustaf A. Gaffert. Published by McGraw-Hill Book Co., Inc., New York, N. Y. Size 6 by 9 in., 592 pages. Price $4.50.

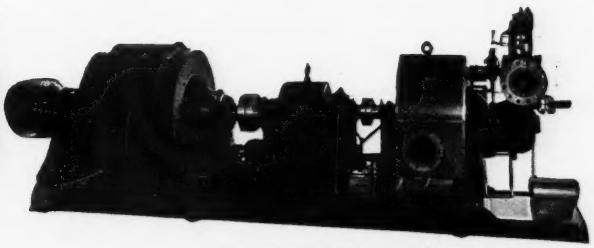
The author of this book, with a background of several years of teaching experience in courses in heat-power engineering and many years' experience in the field of mechanical design of steam power stations, discusses construction, performance characteristics and integration of major and minor machinery.

The book is written from a design and construction viewpoint, making the approach comprehensible to engineering college students. Fundamentals are covered giving the practical man as well as the engineering student the opportunity to expand his knowledge so that he finally comprehends the complete integration of all machinery. This book is primarily designed for a text book and contains sufficient construction data so that a preliminary course may be omitted allowing the student more time to spend studying the engineering aspects of the topics treated.

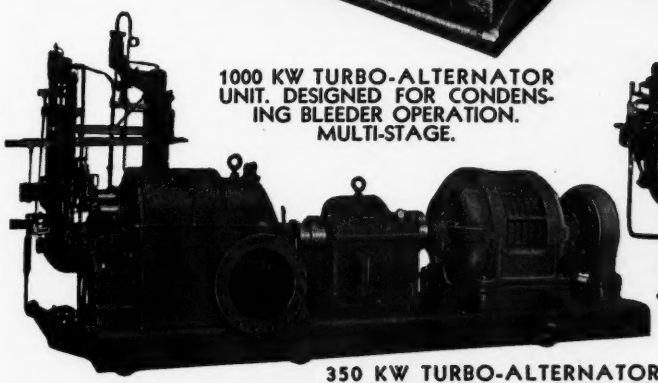
TERRY



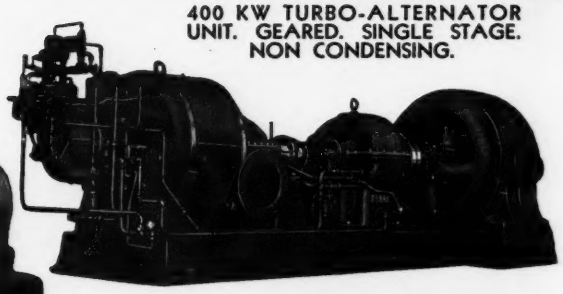
1000 KW TURBO-ALTERNATOR UNIT. DESIGNED FOR CONDENSING BLEEDER OPERATION. MULTI-STAGE.



400 KW TURBO-ALTERNATOR UNIT. GEARED. SINGLE STAGE. NON CONDENSING.



350 KW TURBO-ALTERNATOR UNIT. GEARED. MULTI-STAGE. DESIGNED FOR MIXED PRESSURE BLEEDER OPERATION.



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Federal Regulatory Action and Control. By Frederick F. Blachly and Miriam E. Oatman. Published by The Brookings Institution, Washington, D. C. Size 6 by 9 in., 356 pages. Price $3.00.

During the past fifty years federal intervention in economic fields has developed very rapidly. A thorough analysis of the present system with independent boards and commissions established with administrative, legislative and judicial powers, given in the book serves as a background for the consideration of each of three conflicting proposals for revolutionizing or modifying this system. The three lines of action considered are: (1) That except in the exercise of judicial powers, administrative regulatory agencies shall be placed in executive departments subject to the control of the President; (2) that the power of the courts over the regulatory agencies shall be materially increased; and (3) that the organization, procedures, and relationships of the regulatory agencies as they have evolved over the past fifty years are basically sound and in accordance with the Constitution and its bill of rights, but should be perfected and simplified. The authors support the third or revisionist plan.

Frog-Leg Windings for Direct Current Generators and Motors. By C. S. Siskind. Research Bulletin Series No. 70. 36 pages. Published by Engineering Experiment Station, Purdue University, Lafayette, Ind. 1940. Price 25 cents.

In presenting this paper dealing with the principles underlying the construction of the "frog-leg" winding, the author has attempted to show that it is, in reality, a combination of the two well known types (lap and wave) of windings operating in parallel. Because of its general appearance, the engineers of the Allis-Chalmers Co. who developed it have called it the "frog-leg" winding. The unique feature of this winding is the possibility of embodying one lap coil and one wave coil into a single unit, an arrangement permitting a saving of space in the slots and in the labor of winding. The resulting winding is equalized 100 per cent and requires no equalizer connections.

NEMA Industrial Control Standard—The new Industrial Control Standard superseding the edition of August, 1937, contains general standards and definitions applying to resistors, contactors, brakes, auto-transformers and reactors, a.c. and d.c. controllers; machine tool, synchronous motor, printing press and mine hoist control; magnetic control for steel mill auxiliaries, overhead traveling and floor operated cranes; terminal markings and guides to specifications for building equipment control apparatus. Copy of the Standard may be obtained for $1.00 by writing to the National Electrical Manufacturers' Association, 155 East 44th Street, New York, N. Y.

Boiler Operator's Guide—First Edition. By Harry M. Spring, Jr. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. Size 6 by 9 in., 353 pages. Price $3.00.

This book is a thorough, practical manual covering construction, operation, inspection and maintenance of steam boilers. Installation, design and distinctive features of a wide variety of boilers from the common fire tube

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(5" *Fig. 142*)

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Engineer John Salas (shown above) pointed out a 5" Iron Body Globe Valve which has given trouble-free performance on the 100 lb. main steam header for 47 years. Now check his actual cost figures at the left and you'll see why he says "Jenkins Valves in our plant have proved an economical investment".

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The Simplex Gyrometer provides an inexpensive "bookkeeper" for totalizing the flow of Boiler Feed, Condensate, Steam, Air, Gases and Corrosive Liquors. It is extremely accurate over wide flow ranges. Priced lower than you might think. Write for descriptive bulletin.

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Contains every possible handle-hook-up from midget sliding bar to heavy duty 6" head ratchet. 28 double-hex sockets from ¼" to 1⅝".

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types to the high pressure steam generators are covered. A clear picture of equipment necessary for safe economical boiler operation is given in the chapter on appliances and auxiliaries.

The book also contains 310 questions with answers, typical of those asked on license examinations. Operating engineers and boiler inspectors should find this book a handy and modern handbook specializing on boilers and boiler equipment.

A Dictionary of Metals and Their Alloys. Edited by F. J. Camm. Published by the Chemical Publishing Co., Inc., 148 N. Lafayette St., New York city, 5½ by 8½ in., 245 pages, cloth bound. Price $3.00.

This book, arranged in dictionary form, covers the composition, characteristics and description of metals and their alloys, with special sections on plating, polishing, hardening and tempering, metal spraying, rust-proofing, chemical coloring, etc. It is said to be the first book of its kind yet published and gives in convenient form information that the modern engineer must have at hand to make the effective use of materials available today with special properties intended for particular uses.

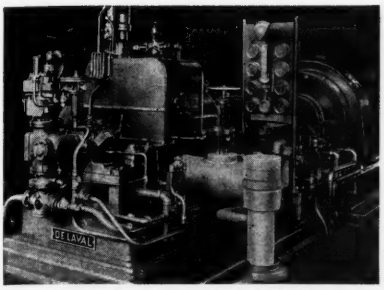
Boilers, Superheaters, Economizers, Air Heaters and Piping 1939, is a report of the Boiler Subcommittee of the Prime Movers Committee of the Edison Electric Institute and has been published by the Institute as Publication No. G10. It may be obtained from the Edison Electric Institute headquarters at 420 Lexington Ave., New York. Price 80 cents to members, $2.00 to non-members in the U. S. A. It is a report of operation of a large number of utility plants throughout the country.

Coal—By Elwood S. Moore. Second Edition. Published by John Wiley & Sons, Inc., New York, N. Y. Size 6 by 9 in., 473 pages. Price $6.00.

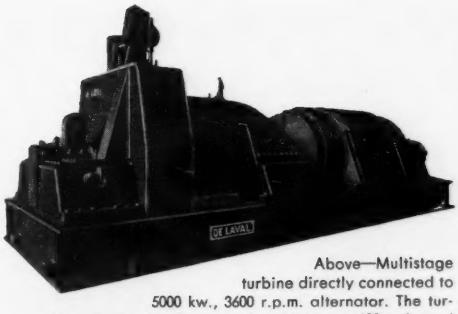
The author has written this book in simple, easy-to-understand language and has included a number of illustrations, charts and tables so that even those without scientific training will find it interesting.

The story of coal has always been very fascinating and with the advent of new viewpoints, new discoveries and new methods, the subject has become more interesting. Physical and chemical properties of coal, the origin of coal, methods of classification and structural features are discussed. Prospecting, valuation of properties, methods of extraction, modern uses and preparation of coal for the market, coal resources of the world and geographical distribution are treated in detail.

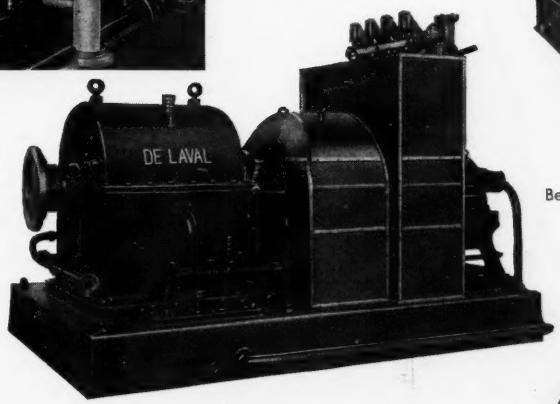
Revere Weights and Data is a new 36-page handbook containing practical and complete tables of weights and data on copper, brass and bronze products. Every weight is expressed in three significant figures and in addition to direct weights on standard alloys, conversion factors are provided for determining the weights of special alloys. Other tables include conversion tables for weights and measures, temperatures and physical and chemical properties of different alloys. Copies will be sent free of charge to engineers, draftsmen, estimators and designers making their requests on company letterheads, giving their position. Revere Copper & Brass, Inc., 230 Park Avenue, New York City.



At left—Bleeder turbine receiving steam at 175 psi. gage and 100° F. superheat, but with provision for adding stages when 575 psi. boiler is installed later on. Steam will then be bled at two different pressures for operation of present low pressure equipment and for heating.

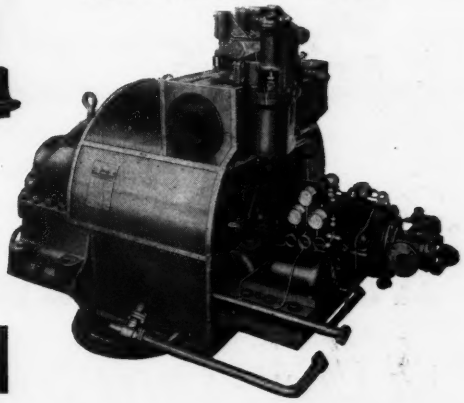


Above—Multistage turbine directly connected to 5000 kw., 3600 r.p.m. alternator. The turbine is designed to receive steam at 455 psi. and 720° F. and to exhaust to a 28½ in. vacuum.

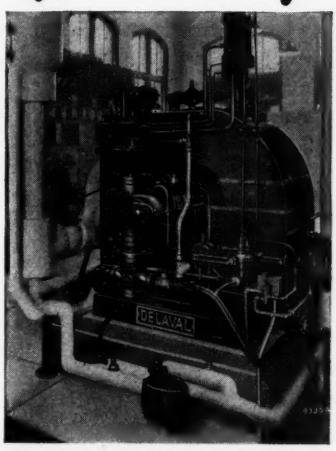


One of two 1200 hp. multistage geared turbines to drive mechanical draft fans.

Below—One of three 10-stage turbines for driving boiler feed pumps; 1250 hp. each at 3500 r.p.m.



Your plant can be fitted with a DE LAVAL TURBINE



200 kw. geared multistage turbine; governing arrangement controls turbine output according to demand for heating steam in hospital.

The controlling reason for selecting steam turbines for power supply in industrial plants and for driving auxiliaries in central stations is that they can be adapted to take advantage of special conditions.

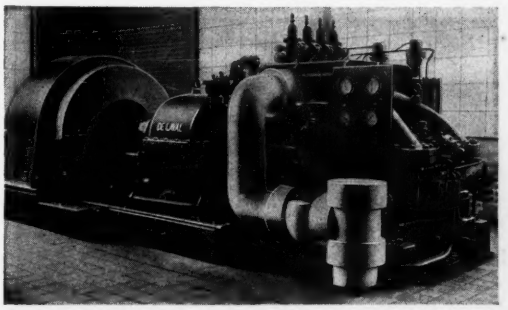
Turbines are available at all times; ready to run so long as there is steam pressure.

In suitable co-ordination with the heat or process cycle they produce power inexpensively as a by-product.

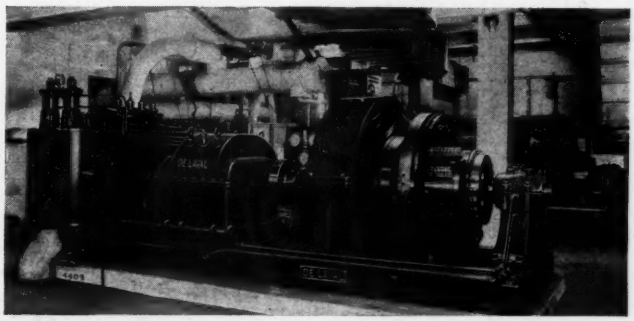
They are readily susceptible to speed control, either manual or automatic.

State your requirements so that our engineers can recommend the most suitable arrangement. Ask for leaflet T-3516, "Modern Turbines Reduce Costs"

DE LAVAL STEAM TURBINE CO., TRENTON, N. J.



Geared multistage turbine arranged for extraction and condensing service and driving 850 kw. alternator.



Two geared multistage turbines driving 1000 kw. generators. Condenser circulating water is supplied from cooling towers on the roof and bled steam is used for heating. Double the capacity of former reciprocating plant, occupies same floor space.

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in Every Dart Union

You get reserve seats in Darts—seats that are always there, ready for *repeated installation.* For good reason: Darts' two spherically-ground bronze seats keep fit even under tough conditions and *make up tight again and again.* That means lower cost per tight joint. And that's why so many plant men who try Darts stick with them. Tell us what size union you use most, and we'll send you a Dart to try, free. You can't lose on that. And there's plenty to gain.

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UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.
Sales Agents: The Fairbanks Company, New York, and all branches
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Industrial Research

FIFTEEN million Americans now work at jobs which did not exist in 1900, said Everett S. Lee, head of the General Electric general engineering laboratory at Schenectady, in an address on the "Practical Applications of Research" at Providence, R. I., in May at a dinner of executives celebrating "Research Day in New England."

"These jobs exist today because, through research, industry has been able to develop hundreds of new products. And it has been able to make them so inexpensive that millions of people have been able to buy them."

He said that there are now 1700 distinct research groups in America, employing some 50,000 workers and spending 150 to 200 million dollars a year, but that there is still room for more research. In 1938 more than 150,000 manufacturing concerns were without research laboratories.

"The job of research is to find new things. Test tube babies, we call them. From the test tubes of industry have come many of the jobs that keep America busy.

"The year 1929 was not a happy one. We all remember what happened then. But in 1929 we did not have streamline trains, television, transoceanic passenger air service, synthetic rubber, fluorescent lighting, colored home movies, new plywoods stronger than steel, many new plastics and resins, polarized glass, building blocks, fibre glass for insulation and textiles, synthetic hosiery replacing silk, synthetic vitamins, sulfanilamide and sulfapyridine, drugs that kill the deadly streptococcus germs and which are being credited with the decline in deaths from pneumonia. All these have been the products of research, ability, hard work, perseverance, and faith."

Mr. Lee discussed electrical research at length and showed a photograph, which cost $10,000 to obtain, of a high-voltage surge on a transmission line caused by lightning. He explained that the photograph helped in the design of protective devices.

"Sympathy for research on the part of those who direct is the fountain source of new achievement. Particularly are we fortunate that this is recognized in the electric light and power industry where the expenditures for research are continuous, both on the part of the manufacturers who produce the equipment and on the part of the operators who use it.

"While it is not possible to separate out with definiteness that portion of the enormous advance, it is fair to say that the part played by research is so potent that its dimunition would be looked upon with fear.

"This is the situation in the electric light and power industry where the average power rate for residential use has been reduced from 25 cents per kilowatt-hour in 1882 to an average of 8.7 cents per

(Continued on Page 106)

Swartwout FEED WATER HEATERS

Save Trouble and Money for Hundreds of Satisfied Users

You can have an adequate continuous supply of oxygen-free hot water for your boilers, assured by Swartwout's sound safe construction and *guaranteed* trouble-free results. Such performance cuts maintenance costs — keeps your plant running smoothly for profitable production. • Swartwout Heaters are *engineered to fit your needs* — correct type, size and storage capacity. These few examples show a variety of sturdily built Swartwout Heaters — some of the hundreds now serving satisfied users. Write today for Bulletins S-18-D and S-193.

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Feed Water Regulators • Pump Governors • Feed Water Heaters
Master Controls • Reducing Valves • Separators • Exhaust Heads

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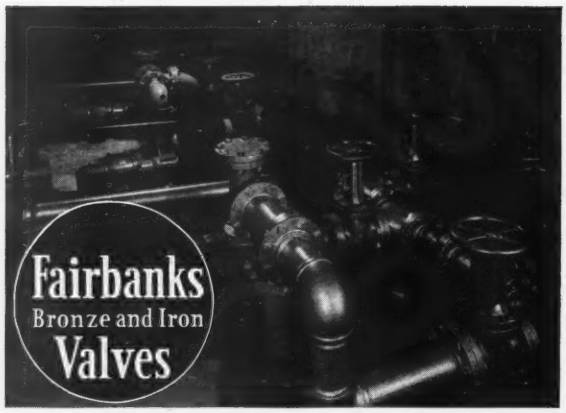

Illustration shows another typical installation of Fairbanks Iron-Body Valves that have been in use for many years and are still giving good service. The extensive use of Fairbanks Valves in prominent industrial plants throughout the country is conclusive proof that they operate easily, shut tightly, repack easily, renew quickly and are low in maintenance cost.

To guard against failure at points where our long experience has taught us that failure is most likely to occur, we make Fairbanks Iron Valves of special semi-steel, which has 66 2/3 more tensile strength than ordinary cast iron, and distribute the metal to give the greatest strength where needed. Threads are accurately cut. All parts are machined to exacting standards of precision. And after assembly every valve is subjected to the most severe test.

Fairbanks Valves are made in bronze and iron for a large range of pressures, in globe, gate, angle, check and cross patterns.

Ask your distributor's salesman to disassemble a Fairbanks Valve and explain the superior construction of each part. You'll probably say you've been overlooking a good thing.

Write for our Catalog No. 21.

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399 Lafayette St., New York, N. Y.

Valves, Dart Unions, Hand Trucks and Wheelbarrows
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kilowatt-hour in 1913 and to 4.2 cents per kilowatt-hour in 1938. Also, the consumption per resident in 1938 was 850 kilowatt-hours compared to 260 kilowatt-hours per resident in 1913. Stating this in another way, the average resident today uses three times as much power compared to 1913, at an increase of only 35 per cent in cost.

"This tremendous reduction undoubtedly has made it possible for more people to enjoy the many benefits which come from the use of electricity because, in 1913 there were only approximately 3,500,000 residential users compared to 22,000,000 in 1938. The industrial and other users have also increased from 336,000 in 1913 to 5,750,000 customers in 1938.

"This expansion of the electrical market has made it possible for the central station industry to increase its number of employees from 79,000 in 1913 to 270,000 employees in 1938, an increase in employment of 341 per cent. Today the residential kilowatt-hour output is some 18 billion, compared to one billion in 1913. Predictions are that this will be 50 billion 10 yr. from now."

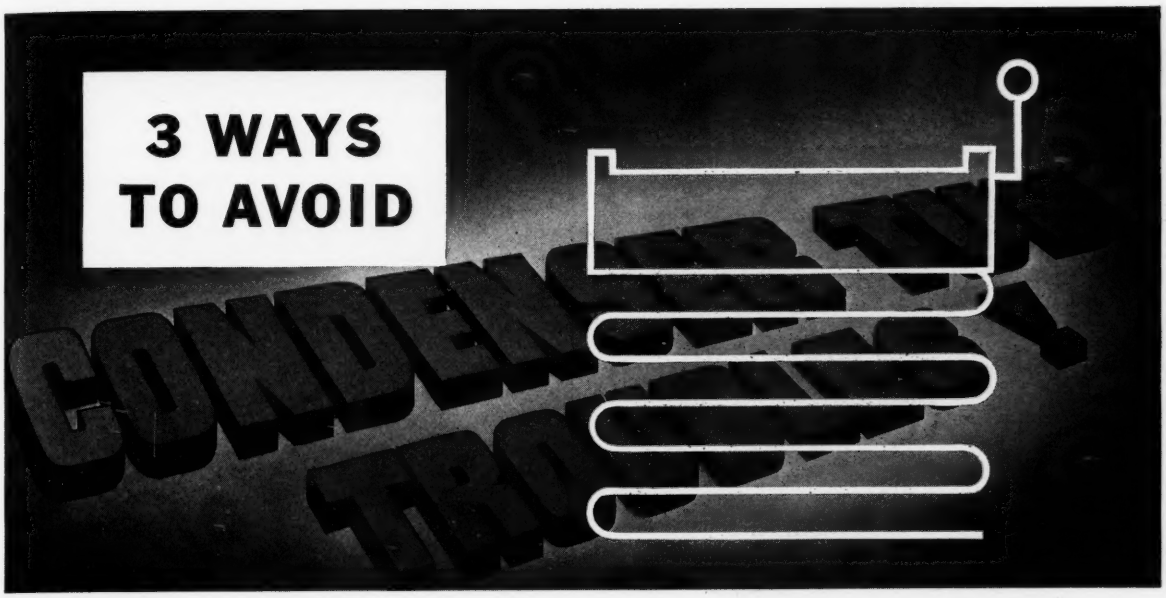
Alloy Steels Dramatized

ALLOY STEELS, those special products contrived in the research laboratories of the world to make possible the tough, sturdy steels demanded by modern industry, are made the subject of a sound motion picture film recently produced by the U. S. Bureau of Mines in cooperation with an industrial concern. The film, entitled "Alloy Steels—A Story of Their Development," is in 16- and 35-millimeter widths and requires 20 min. for showing.

Starting scenes show a toolsmith at work in an old-time shop, using early methods of fashioning tools by hand, the film next depicts the "cementation" process—the making of blister bar steel by adding carbon to wrought iron—a process known by the ancients and re-discovered many years later by European workers.

Scenes which follow continue the portrayal of "milestones" in the history of the development of alloy steels down to modern times when in 1917 the molybdenum deposit at Barlett Mountain, Climax, Colo., became the source of supply for British and American steel makers. In 1918 metallurgists developed the chromium-molybdenum series. In 1919, chrome-silicon steels were introduced, followed in 1921 by chrome-nickel-molybdenum steel; in 1922, by nickel-molybdenum steel; and in 1926, by manganese-molybdenum steel. In 1930 molybdenum again took its place in the manufacture of high-speed cutting tools. Small percentages of tungsten were combined with molybdenum and the resulting steels were standardized. In 1934, research in combining tungsten with molybdenum and other alloyed elements in high-speed steels continued. In 1938, laboratory and field studies brought about improvements in both tools and in pro-

(Continued on Page 108)



Scovill's job is to help you to overcome any condenser tube troubles you may have. If your operating conditions are peculiar, if tube life seems to be too short, if trouble occurs anywhere in the condenser cycle—call upon one or more of these Scovill services:

SERVICE IN METALS— Development work on new alloys takes place continually in Scovill laboratories. The answer to your present problem may be contained in their latest accomplishment. For example — Phosphorized Admiralty—with its resistance to dezincification without the loss of any of the desirable qualities that have made Admiralty so widely used an alloy.

SERVICE IN MEN — Scovill engineering representatives aid you in selecting the alloy which will give the best service under your operating conditions. Later, they return to check up, and if anything has gone wrong they go to work to remove the cause in order that you may have greater condenser tube life. For example: Tubes in one heat exchanger examined had an average life of 11 months. This was considered a normal tube life under the operating conditions but was not long enough to satisfy the user. Scovill engineers recommended the use of a different alloy and suggested that the material would be more economical in final cost even though its first cost was 32% greater than the previously used alloy. The recommended change was made. Tube life was extended to 24 months. An increase of 118%.

SERVICE IN MANUALS — This is Scovill's term for the data compiled from the findings of Scovill engineers during their varied experiences with condenser and heat exchanger tubes. The new revised edition of the well known "Condenser Tube Booklet" is free. We will gladly send you a copy. Fill in and mail coupon.

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think of **SCOVILL, "MASTERS OF METAL"**

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one product . . . three services

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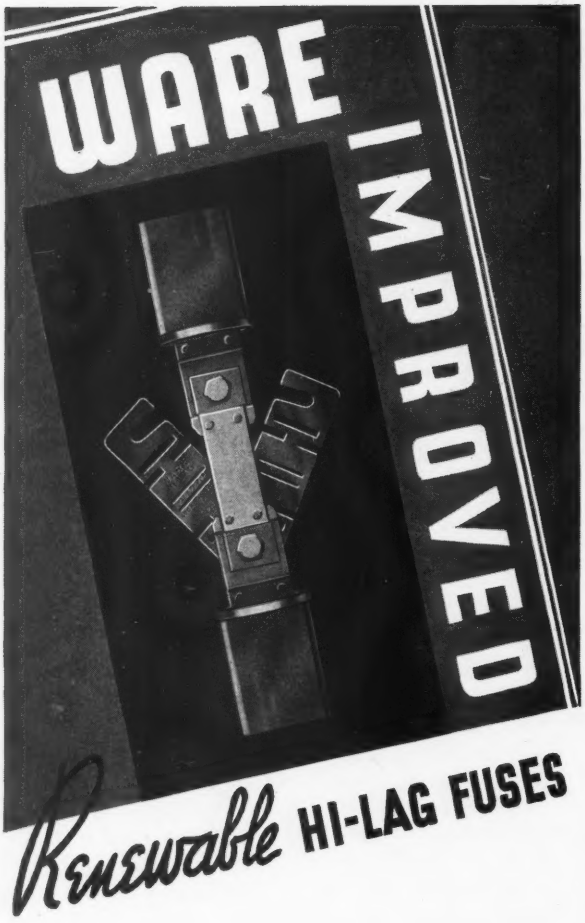


Note these important advantages you get when you specify WARE HI-LAG FUSES:

1. HIGHER LAG ON STARTING LOADS! Exceptionally high time lag eliminates blow-outs caused by starting motors and momentary surges.
2. GREATER STRENGTH AND DURABILITY! New double-bridge, self-aligned knife-blade assembly insures extra strength and longer life.
3. SIMPLIFIED CONSTRUCTION! New double-bridge assembly easier to renew correctly than to overload. Remove only one end of casing to renew fuse. Assembly may be inserted either end first.
4. SPRING TENSION CONTACT! Greater contact surface. Links will not blow because of inadequate or faulty contacts.
5. MAXIMUM PROTECTION—MINIMUM COST! Underwriters approved. 100% protection to your circuits. Construction insures utmost economy of renewal expense. Saving of lost time will more than pay for the fuses. START ECONOMIZING!

Write for our TRIAL TEST OFFER, Sizes and Prices.

WARE BROTHERS
4500 W. LAKE ST., CHICAGO

duction of alloy steel. The reel ends with views in modern steel plants and shows equipment used for the heat treatment and fabrication of steel.

This film, "Alloy Steels—A Story of Their Development," may be obtained for exhibition purposes by applying to the Bureau of Mines, 4800 Forbes Street, Pittsburgh, Pa. It should be stated whether 16- or 35-millimeter width is desired. No charge is made for the use of the film.

Invention Makes Jobs

SPEAKING before the Edison Electric Institute convention at Atlantic City, N. J., Ralph Kelly, Vice-President of Westinghouse Electric & Mfg. Co., said that while the products of inventive genius save labor they actually create more jobs. Seldom does a new product spell doom to its predecessors. It simply creates a new demand or enlarges an old one.

Under the American way of work "our problem is to give the public the best electrical service the world affords, and never to be satisfied that it cannot be improved." It was disclosed that 10 per cent of his Company's investment in plant facilities consists of laboratories, test equipment and service facilities devoted almost entirely to the advance and improvement of the electrical art.

"The keystone of our research down through the years," he continued, "has been to accomplish ends which were practical; for example, to produce lower loss steel for transformers, higher capacity circuit interrupting devices, more efficient lamps or more enduring insulation—but always to accomplish these objectives by thorough methods. Our research has been a tedious, painstaking route to progress. For every way we have discovered to do something, we have probably discovered one hundred ways not to do it. Because we have faith in the future, we are enlarging our engineering and research facilities. We are increasing our efforts to promote the increased use of electric power." He firmly believes that research and invention mean more jobs and new demands for products of industry.

Wire and Cable Standardization

AT A MEETING of the International Association of Electrical Inspectors at Fort Wayne, Ind., June 19, F. V. Calvert of the General Electric Co. expressed the opinion that "There is no question but that most cable troubles have been due to misapplication. This is understandable when you consider that users in the past have been confronted with literally 500,001 possible combinations in trying to choose the proper type of wire or cable for a particular job."

(Continued on Page 110)

LARGER SPROCKETS

MILE-A-MINUTE CHAIN SPEEDS

AMAZING RESULTS

Simply using larger sprockets with more teeth, running chain speeds up to a mile a minute or more, gives an enormous increase in the power-transmitting capacity of Morse Chain.

Where such treatment results in more slip on other drives, the silent chain actually uses centrifugal force to give better contact with sprocket teeth and better load distribution.

NOW *Really* SILENT

So smooth you can hardly hear it.

***Increased* LOAD CAPACITY**

Load capacity goes up directly as the chain speed increases. There is no slip—no wasted power with a Morse Silent Chain—no excessive tension to increase bearing loads.

WEAR *Eliminated*

Research has shown and experience proves that wear is at a bare minimum on Morse high speed chain and sprockets. Driving forces are spread over a greater number of teeth, giving longer life and highest efficiency of any mechanical power transmission.

The greatest advantage of this type of drive design comes where speed ratios are not large, such as from 1 to 1, up to 3 or 4 to 1.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO CLUTCHES

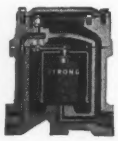
MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

PIPEWRENCH PETE SAYS:

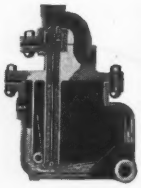
THIS NEWS WENT TO THE FRONT OFFICE... AND NOW THEY CALL ME MISTER!

Steam costs money. The "big shots" know it. And when their new battery of cookers uses 27% LESS, they want to know why. I'm still wonderin' why they gave me an office with my name on the door for tellin' them plain horse sense like this:



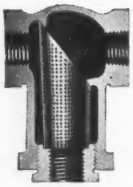
1 STRONG 70-T TRAP for quick-heating cookers, etc. Lets out all the air. Shuts tight soon as steam hits it. Can't dribble because of the exclusive anti-balancing device. Packs as much quality as Strong's larger inverted bucket (80 series) trap. Guaranteed a year.

★



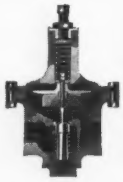
2 STRONG 30 REGULAR TRAP for any drainage job, particularly separators, headers, engine manifolds. Install one and watch it work. You'll still be patting yourself on the back 10, 15 years from now, on account of the Anumetl valves and seats and wear-proof parts.

★



3 STRONG, QUICK-CLEANING STRAINER. Makes reducing valves, traps, controls, etc., live longer and work better, by taking out scale, dirt, grit or sand. Just open the blow-off to clean it.

★



4 STRONG REDUCING VALVES. Type K of complete line shown. Name your own reduced pressure from 85 pounds down, and this valve keeps right on giving it to you. ANUMETL valves and seats guaranteed for a year.

★

HOW DO *YOU* SIZE STEAM TRAPS? Easy method, plus valuable information on installations, etc. Send for Catalog 63-PE1.

The Strong Carlisle & Hammond Co.
1392 West Third St., Cleveland, Ohio
Write for name of your nearest distributor

STRONG
STEAM SPECIALTIES

Standardization, he thinks, has permitted and will continue to permit appreciable reductions in wire and cable costs. "Formerly most cable was tailor-made. This naturally meant high costs and slow shipments. Standardization, on the other hand, permits the user to obtain quick shipments from the manufacturer's stock."

The following six company standard types seem to fit all general services:

1. Single-conductor, 1799 cloth-leaded cable, for primary incoming currents.
2. Interlocking Armor Cable, for large power circuits and additional feeders.
3. Versatol, for general purpose wiring requiring long life, heat and moisture-resisting cable.
4. Flamenol, for applications exposed to oil and acids such as in the machine-tool field. This type cable will not sustain combustion.
5. Tellurium Parkway, for buried control and power circuits.
6. Tellurium Portable, for heavy-duty portable service.

With only a comparatively few types of cable to choose from, Mr. Calvert is convinced plant electricians can easily determine the proper type for each particular job.

Synthetic Rubber Now Under Production

SPEAKING before an invited group of five hundred industrialists, military experts, scientists and representatives of the press, John L. Collyer, president of the B. F. Goodrich Co., made the announcement on June 5 that his company has developed a new synthetic, called Ameripol, which is capable of replacing natural rubber products.

Three important achievements of Goodrich research and production were stressed by Mr. Collyer, these being:

(1) The development over a period of 14 yr., of a synethetic which in many of its important properties is equal or superior to natural rubber, and can be processed and vulcanized like the natural product. The material is an exclusive product which does not infringe any existing patents. This Liberty Rubber has been named Ameripol, which signifies a polymer or recombination of molecules of American materials.

(2) Goodrich has had in operation for more than a year and a half a pilot plant producing Ameripol, and it is now being made in a semi-commercial plant. A manufacturing plant which will have a daily capacity of several tons of Ameripol is under construction, to be ready this fall. Additional units of the same type, it was emphasized, can be constructed to produce any required amount.

(3) The new Goodrich tires use Ameripol to replace natural rubber in proportions varying from 50 to 100 per cent. Mr. Collyer emphasized that if the industry were to replace with Ameripol the natural rubber in its tire treads and sidewalls alone, it would

(Continued on Page 112)

NOW!— a new TUBE-TURN TEE!

Yes, it's here!—a new and greatly improved seamless TUBE-TURN Welding Tee, scientifically designed to provide full pipe strength *without unnecessary weight.*

In the illustration below note the gradual reduction in wall-thickness from *maximum* at the highly-stressed crotch, down to *nominal* at the bottom of the tee. Full strength is assured by the proper *placing* of reinforcing—*not* by mere excess thickness throughout.

Note, too, the longer outlets—the accurately-machined ends. This makes lining-up and welding *easier.*

The new TUBE-TURN Tees *cost no more.* They give you a better, neater, stronger job—*reduce* welding and handling costs.

Complete data on the new TUBE-TURN Tee and full line of other TUBE-TURN fittings for pipe welding is given in the new TUBE-TURN Catalog and Data Book No. 109. Write for your free copy today!

TUBE-TURNS, Incorporated
Louisville, Kentucky

The word "Tube-Turn" is NOT a necessary general trade name for welding fittings. It is the registered trade-mark for the products made by Tube-Turns, Incorporated, under their patents.

TUBE-TURNS
Incorporated
LOUISVILLE, KY.

LEAKS
avoided or stopped
by SMOOTH-ON No. 3

at threaded or flanged joints

The surest way to *avoid* leaks of screw threads and gasketed, ground or press-fitted joints is to make them up with Smooth-On No. 3. However, if this has not been initially done and a leak develops, reassembly with Smooth-On will restore tightness and prevent recurrence of the leak.

Smooth-On maintains tightness against steam, water, gases, oils and many chemicals, regardless of vibration or extreme pressure and temperature changes. On screw threads, Smooth-On also acts as a lubricant for easy assembly and permits the joint to be taken apart.

Buy Smooth-On in 7-oz., 1-lb., 5-lb. cans or 25-lb., 100-lb. kegs from your supply house, or if necessary, from us. For your protection, insist on Smooth-On—used by engineers since 1895.

FREE

The many money-saving applications of the various Smooth-On compositions are concisely explained in a 40-Page handbook, based on the experiences of thousands of engineers. This handbook illustrates dozens of ingenious practical repair short-cuts on plant equipment. Fill in and mail the coupon for your copy.

SMOOTH-ON CEMENTS

for the Motor Car and Boat, Home, Factory and Power Plant

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570 Communipaw Ave., Jersey City, N. J.
Please send SMOOTH-ON HANDBOOK.

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Address .....

8-40 .....

Do it with **SMOOTH-ON**

reduce by approximately one-half America's consumption of the natural product.

Ameripol today costs much more than rubber. For that reason, these new products will be higher in price. With increasing production, however, economies may be expected which will reduce the price.

Dr. Waldo L. Semon, discoverer of Goodrich's widely used rubber-like synthetic, Koroseal, who, with his assistants, is credited with the development of Ameripol, outlined the characteristics of the new Liberty Rubber, and said his goal had been the specific problem of developing a relatively low-cost material that would serve as a general replacement for rubber and could be processed and vulcanized like natural rubber. "Our group," he stated, "finally produced solely from American raw materials, a synthetic which, in many of its important properties, is equal or superior to natural rubber."

The basic raw materials from which Ameripol is made is American petroleum. By the cracking process petroleum is broken down to a mixture of simple molecules and from this mixture can be separated a gas which under pressure liquefies to give butadiene. This is mixed with other ingredients prepared from natural gas and air and then made into a milky emulsion, using soap produced from American agricultural sources. Upon heating and agitation, these ingredients react to form an emulsion of synthetic rubber, which is similar to the latex obtained from rubber-producing trees. From here on, he added, the proceess of obtaining a sheeted rubber is quite like that used for natural rubber. The latex is coagulated with acid, producing a curd. This is then sheeted and dried to give the synthetic Ameripol.

According to the best authenticated figures, consumption of synthetic rubber last year in the United States amounted to 1700 tons against a consumption of natural rubber totaling 592,000 tons.

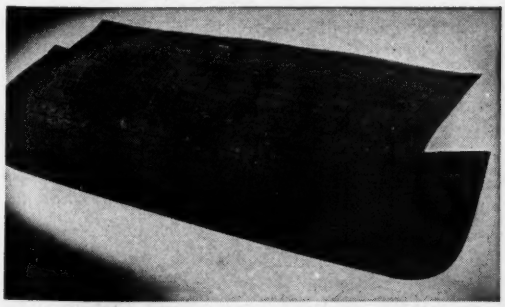
Business as Usual

SPEAKING for the coal and stoker industries, Marc G. Bluth, secretary of the Stoker Manufacturers Association and manager of the Chicago office of the National Coal Association, at the 14th annual convention of the Northwestern Retail Coal Dealers Association, Duluth, Minn., June 27 and 28, expressed enthusiastic optimism for the immediate outlook of business in these fields. "Business is going on as usual in the coal and stoker industries," he said. "Rearmament and defense programs are not interfering with the normal pursuit for business in our industries today. The future, of course, is uncertain. How world-wide conditions may ultimately affect the coal industry and the stoker industry in particular is anyone's guess. It is reasonable to conclude, however, that in any national preparedness program the bituminous coal industry will undoubtedly increase business over normal expectations. The bituminous coal industry is prepared to furnish almost any amount of tonnage required as an accelerated tempo of industrial activity continues. The National Coal

(Continued on Page 114)

KEEPING 'EM ROLLING — By WESTCOTT

JOE'S METHOD . . . *Cut Down Replacements by Using J-M Service Sheet*



J-M SERVICE SHEET (Style No. 60): J-M Service Sheet has proved its durability under the most difficult operating conditions. One side is graphited; the other plain and ruled to make measuring and cutting easy.

MANY gasket failures boil down to just one thing—inferior sheet packing. A good percentage of them are as unnecessary as they are expensive. For in J-M Service Sheet, you get a tough asbestos material that lasts longer under practically all operating conditions. It is dense, yet resilient, and, most important, it is always uniform in quality. Stock it as long as you wish—it does not deteriorate with age. A tryout will show you why more and more engineers are standardizing on J-M Service Sheet. For details and facts on the complete J-M line of quality packings, send for the J-M Packing Catalog. Johns-Manville, 22 East 40th Street, New York, N. Y.

JOHNS-MANVILLE JM PRODUCTS

JOHNS-MANVILLE PACKINGS & GASKETS

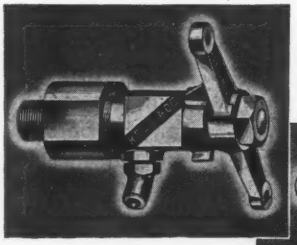
THERE'S A DISTRIBUTOR NEAR YOU

Steam-proof and Leak-tight RELIANCE GAGE COCKS *end repair and replacement costs!*

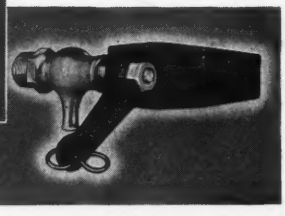
• You can instantly stop the annoyance of leaking, sizzling gage cocks by installing Reliance Equipment. Now made steam-proof and leak-tight, Reliance spring-operated Gage Cocks save you many a repair dollar or the cost of replacements.

The non-corrosive stainless spring, of remarkable strength and resiliency, is designed for unusually long life—has withstood tests of more than 25,000 "pulls." Renewable stainless seat and valve. Cone valve ground and lapped to microscopic glass-smooth finish to resist cutting action of steam and water. Unusually sturdy, built for long service for up to 450 lbs. pressure. End your gage cock worries with this Reliance patented valve. Write today for Gage Cock Bulletin.

The Reliance Gauge Column Company
5902 Carnegie Ave. • Cleveland, Ohio



Left — Reliance Forged Steel Gage Cock, chain operated, for pressures to 2000 lbs. Ends all gage cock troubles.



Right — Reliance Weighted Gage Cock, self-closing. Proved steam-tight and efficient at pressures to 250 lbs.

Reliance
Boiler Safety Devices since 1884

Association has just issued a public statement assuring the Government and the people of the United States that the industry can take care of defense needs and demands for fuel, power, light, and heat."

In line with these views he quoted a statement made by the National Coal Association, part of which is as follows:

"It is our duty to report to the people of the United States that the bituminous coal industry is prepared to answer promptly any demands you may make upon it for the defense of the nation. The nation has indicated its determination to prepare itself for any eventuality. Light every fire in every existing power and industrial plant and the bituminous coal industry will provide the fuel for those fires. Step up the productivity of the power and industrial plants necessary for the swift rearmament of the nation and cars of bituminous coal will be at their doors as soon as needed. Transportation facilities are available for prompt service. Any defense program must depend largely on power and transportation. These industries are preparing to meet unusual demands. The bituminous coal industry has spent millions of dollars keeping intact bituminous coal mines that were opened to aid the nation in the emergencies of the World War of 1914-1918. During the dark years of the depression, the bituminous coal industry spent millions of dollars in modernizing its mines and preparation of plants so that bituminous coal can be produced swiftly. Those mines assure a flexibility of bituminous coal production that can pour out greater tonnages of the universal fuel at the rate and in the amount that America may demand. Thanks to the improvements in preparing and using fuels developed by the industry, the industries of the nation can get more energy from every pound of bituminous coal they use. We are, therefore, able to report to the people of the United States on behalf of the bituminous coal industry that 'We are prepared for every acceleration of productive activity for the defense of the nation.'"

Thomas S. Holden, Vice-President of the F. W. Dodge Corporation, acknowledged to be one of the country's real authorities on building, was quoted as saying that the defense program should add momentum to the continued upswing of building construction; that the recent intensification of the European war has not yet affected the building industry but that there are danger signals ahead, due to emotional phases, a possibility of a rapid rise in building costs, and possibility of imposition of Government controls and restrictions in order to give priority to construction essential to the national defense program. "Mr. Holden," said Bluth, "is a very deep student of building industry affairs, but I believe that in spite of rising costs there will be an increasing rise in building because the spending program for defense purposes will eventually create a public desire to place money and cash into all types of tangible investments so that we must attempt to foresee what will happen in the building industry and prepare ourselves to take advantage of the new business which will come about in spite of these apparent future possibilities."

(Continued on Page 116)

Check These Link-Belt Features

FOR EFFICIENT BELT CONVEYOR OPERATION

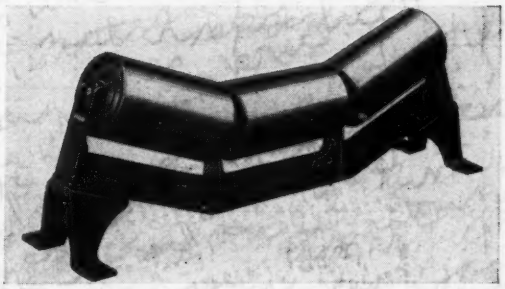
1. Anti-Friction Efficiency. Roller bearings take high radial and thrust loads.

2. Strength and Simplicity. Riveted frame, strong brackets and sturdy rolls make a trouble-free assembly. No bolts or nuts to work loose.

3. Ease of Lubrication. High-pressure grease system is highly accessible and bearings are protected by labyrinth seals which retain grease and keep out dirt.

4. Belt Protection. Idlers are smooth with rounded edges. Narrow gap between rolls prevents pinching.

5. Accurate, Balanced Rolls. Accurate machining assures perfect alignment of bearings and uniformity of parts in the complete idlers.



Heart of the efficient belt conveyor of today is the idler. To this all-important element Link-Belt has given continuous attention as a result of which present Link-Belt designs offer the most in dependability and low service cost.

Get information now on better belt conveyor equipment—whether for modernization or new installation needs.

LINK-BELT COMPANY

The Leading Manufacturer of Equipment for Handling Materials and Transmitting Power 8171C

INDIANAPOLIS CHICAGO PHILADELPHIA ATLANTA
DALLAS SAN FRANCISCO TORONTO

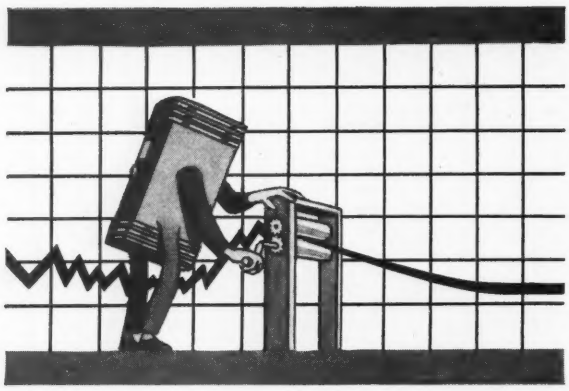
Branch offices and warehouses located in all principal cities

LINK-BELT

A TYPE FOR EVERY SERVICE

BELT CONVEYOR EQUIPMENT

IDLERS • TRIPPERS • BELTS • PULLEYS • BEARINGS • TAKE-UPS • DRIVES

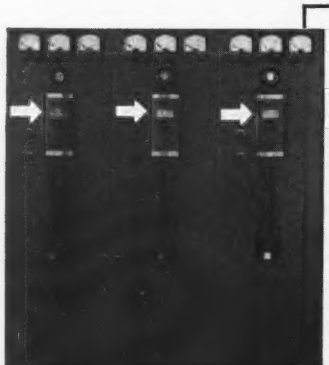


WRING OUT YOUR VOLTAGE BUMPS with G-E Diactor Regulators

HERE'S a little fellow who can do a big job for you. Whether your voltage-regulation problem involves a new generator installation, replacement of old regulating equipment, or providing adequate regulation for unregulated machines already in service, you will find the G-E Diactor regulator the answer.

His wide-range, quick-action rheostatic element gives voltage regulation that is really *smooth* by providing an almost infinite number of smooth resistance steps from practically zero to the maximum. He holds the voltage close to the desired value without hunting or instability. After a change in operating conditions, he quickly returns the voltage to normal.

A specialist will be glad to tell you all about the Diactor regulator. Just call him, at the G-E Office near you. General Electric, Schenectady, N. Y.
Bulletin GEA-2022



Modern streamlined Diactor regulators mounted semiflush

DIACTOR REGULATOR ADVANTAGES

Direct Acting—fast in operation

No Vibrating Contacts—reliability and long life

Electrically Damped—no dashpots

All Parts Normally Stationary

Small, Compact—saves space

Simple Construction—only six leads required

Prices Are Low—starting at $70 list

GENERAL ELECTRIC

The thought was expressed that even if people are not buying or building new homes, they will do something in the way of modernizing. The need for modernization was indicated by a recent survey made by a large building firm supplying a national building product. This survey showed that 62 per cent of American homes are in need of immediate repairs. The survey discloses that 44 per cent of the U. S. dwellings need minor repairs, 15 per cent have major needs, while over 2 per cent are actually unfit for habitation. This survey further indicates that these repairs will fall into three major classifications: 24 per cent require changes in heating plants; 18 per cent require painting; and 15 per cent need new roofs.

To meet this situation, it was stated that the coal industry, along with electric power utility companies, the stoker industry, smoke abatement organizations and other civic bodies, has launched numerous cooperative advertising and sales promotional projects in a number of important cities.

In concluding his paper, Mr. Bluth stated that: "As for the stoker industry, I firmly believe, based on a close study and observation of conditions in the industry, that 1940 will prove to be a record-breaking year. The stoker itself is a fuel conservationist and it will find a place in the niche of American industry with the backing of the industry's aggressive leadership, advertising and sales promotional efforts and last, but not least, the improvement in the sales methods of stoker distributors and dealers."

A. S. H. V. E. Meets in Washington

AT THE Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, which convened at the Wardman Park Hotel, Washington, D. C., June 17, the 350 members who registered took part in three technical sessions and numerous entertainment features arranged by the Washington, D. C., Chapter. President F. E. Giesecke presided. For a number of years this Society has carried on research projects and the papers presented at this meeting reflected not only the work of special committees but also the research work of individuals and manufacturers.

F. C. Houghten, director of the Society's Research Laboratory, presented a paper entitled, "Summer Cooling Load as Affected by Heat Gain Through Dry, Sprinkled and Water Covered Roofs," by F. C. Houghten, H. T. Olson and Carl Gutberlet. Other papers were: "Air Conditioning Design of New Federal Office Buildings," by W. A. Brown; "Dirt Patterns on Walls," by R. A. Nielsen; "Study of Changes in Temperature and Water Vapor Content of Respired Air in the Nasal Cavity," by Professor L. E. Seeley; "Summer Cooling Requirements of 745 Clerks in an Office Building," by Dr. W. J. McConnell and M. Spiegelman; "Fever Therapy Locally Induced by Conditioned Air," by Dr. M. B. Ferderber, F. C. Houghten and Carl Gutberlet; and "Methods of Rating the Noise from Air Conditioning Equipment," by John S. Parkinson.

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Gould Pumps, Inc.
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Mattison Machine Works
Milcor Steel Co.
Mono Service Co.
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Morganite Brush Co.
Morse Chain Co.
National Automatic Tool Co
National Carbon Co., Inc.
National Process Co.
Nation Vulcanized Fibre Co.
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Pneumatic Scale Corp., Ltd.
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Reeves Pulley Co.
Reliance Elec. & Eng.
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Republic Flow Meters Co.
Republic Steel Corp.
Resmans Prod. & Chem. Co.
R. W. Rhoades Metaline Co., Inc.
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Sangamo Electric Co.
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Sloan Valve Co.
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These are some of the 845 companies that sent representatives to the national N. I. A. A. Conference last year . . . to take part in group discussions of marketing problems . . . present case studies . . . and study the advertising methods of industrial leaders.

You are invited to the 18th annual Conference of industrial sales promotion and advertising executives in Detroit next September . . . to get new ideas and information that will make your 1941 program more effective, more profitable. Write now for details.

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National **INDUSTRIAL ADVERTISERS** *Association*
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For the Engineer's Library

Controls Meters and Instruments

1—Temperature Regulators — Bulletin 11 illustrates and describes 5 types of Foster temperature regulators, giving application, and operation of each type. General installation and Ordering instructions are included in the bulletin. Foster Engineering Co.

2—Controls—Meters and Instruments —Bulletin 355 illustrates and describes meters. Industrial Glass Stem Thermometers, manufactured as a supplement to a complete line of recording and controlling thermometers, are described in bulletin 524. A complete line of modern thermometer and pyrometer controllers, for gas, electric and oil-fired industrial furnaces, kilns and ovens, are described in a revised bulletin 548. Modern round-chart recording voltmeters and ammeters are described, together with some of their more common applications, in bulletin 543. The Bristol Co.

3—Instruments — Bulletin S2-2 illustrates and describes our very complete line of thermocouples, thermocouple wire, lead wire, insulators and protecting tubes. Wheelco Instruments Co.

4—Thermometers and Pressure Gages —Catalog No. 605 covers the complete line of Circular Case Thermometers and Pressure Gages, Indicators, Recorders and Controllers, as well as self-contained and portable models. Seventeen constructional features of the electric controller are illustrated and the principle of operation is described in detail. The Brown Instrument Co.

5—pH Meter and pH Recorder— Folder 910E describes the Cambridge Electron-Ray pH Meter which reproduces readings to 0.01 pH. Folder 910T describes the Cambridge Thermionic pH Recorder with which pH values can be continuously recorded with laboratory accuracy under plant operating conditions. Cambridge Instrument Co., Inc.

6—Control—A new 66-page catalog on Limitorque Automatic Valve Controls illustrates and gives full facts and figures about this line of controls for operating valves from 3 to 96 in. in diameter as well as for many other purposes where remote control is desired. Philadelphia Gear Works.

7—Flow Meters—Bulletin 401 illustrates and describes Ring Balance mechanical flow meters applicable for all commercial fluids. Ring Balance Instrument Co.

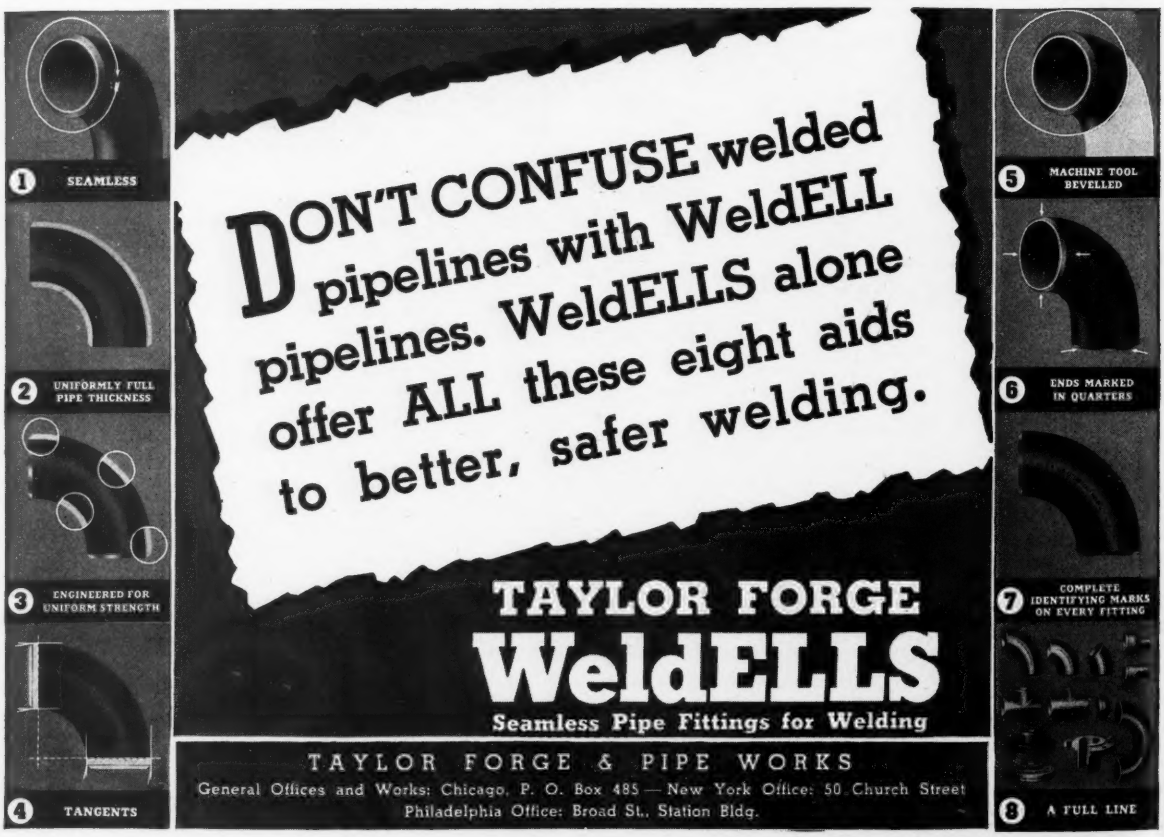
8—Instruments—A new bulletin on instruments for measuring speed, frequency and rates of vibration covers mechanical and chronometric hand tachometers, speed indicators, tachoscopes, etc., and also our Frahm Vibrating-Reed Tachometers. Frequency meters and vibration-per-minute indicators. James G. Biddle Co.

9—Instruments — Catalog 4120 illustrates and describes Roller-Smith Panel Type 3 and 4 in. Instruments. Roller-Smith Co.

Water Treatment

10—Protective Coatings—This bulletin features the preservation of boiler metal and the equipment for applying it to internal tube surfaces, describing Apexior No. 1 for hot wet metal surfaces of boiler room equipment, where there is exposure to contact with hot water and steam at temperatures above 175 deg. F. Apexior No. 3 is recommended for cold wet or hot dry metal surfaces exposed to water or moisture at any temperature not over 125 deg. F. or any dry atmospheric contact in a sheltered location at any temperature not over 450 deg. F. The equipment for applying is described in detail, and instructions for applying are included. Dampney Co. of America.

11—Scale Prevention—An 8-page bulletin describes the Activator Process and its application for preventing scale in the generation of steam. The bulletin also makes reference to successful use of the Activator Process for scale prevention in cooling towers, water jackets and piping. Activator Process Sales Co.


1 SEAMLESS
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6 ENDS MARKED IN QUARTERS
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12—Dry Chemical Feeder—Bulletin No. 2345 describes Permutit's new oscillating type dry chemical feeder, covering operating principles and design. Capacities and specifications are included in the bulletin. The Permutit Co.

13—Scale and Rust Removal—A new illustrated 20-page booklet describes a recently developed material, Oakite Compound No. 32, which is especially designed to provide high rust and scale removal properties. Oakite Products, Inc.

14—Decarbonator for Degasification—Complete details of construction and application of the Cochrane Decarbonator are given in Publication 2975. Cochrane Corp.

Pumps

15—Pump—This 4-page leaflet, R-6108, deals with the effect of water conditions on the selection of pump materials and discusses the effect of these various factors on different pump materials with particular reference to the influence of pH value. The information required to select intelligently the proper materials for pumps is outlined and a chart is included showing the proper materials recommended for various pH ranges. Allis-Chalmers Mfg. Co.

16—Pumps—A new 20 page catalog covers a complete line of centrifugal, simplex and duplex pistons, and plunger pumps; also vacuum pumps. Warren Steam Pump Co., Inc.

Valves and Piping

17—Expansion Joints—A revised edition of a 16-page bulletin EJ-1907 on Yarway Gun-Pakt Expansion Joints which have several interesting engineering features. Revised 12-page condensed catalog G-1305 on Yarway Steam Plant Equipment covers all major products. Yarnall-Waring Co.

18—Bar Stock Valve—A new booklet on Bar Stock Valves contains complete information, dimensions, and application recommendations for bronze, carbon steel, and stainless steel bar stock valves. Reading-Pratt & Cady Division of the American Chain and Cable Co., Inc.

19—Steam Traps—Modernized inverted bucket type steam traps are illustrated and described in a 20-page bulletin covering design, operation, application and installation. Revised capacity tables are included in the bulletin. Kaye and MacDonald, Inc.

20—Gage Valves—Bulletin 401 covers a complete line of boiler water gage valves, including valves for low and high pressure equipment and certain boiler gage specialties. The Reliance Gauge Column Co.

Materials

21—Rubber—A 30-page booklet entitled Typical Examples of Goodrich Development in Rubber contains illustrations and descriptions of many of the most unusual modern uses for rubber. The B. F. Goodrich Co.

22—Rubber Mechanical Goods—A new 24-page catalog on mechanical goods illustrates and describes typical examples of Goodrich developments in unusual applications of rubber, including a discussion of rubber transmission belting, together with instruction on how to splice the belting. Data includes tables on minimum pulley diameters, transmission belting horsepower, a simple method for correcting horsepower ratings and a discussion on selecting proper grade and type of belt. The B. F. Goodrich Co.

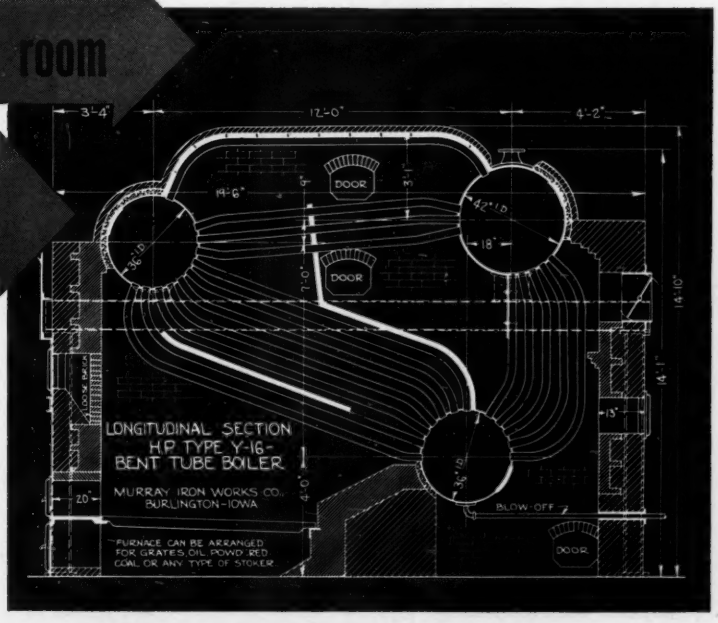
23—Creep of Some Chromium-Molybdenum Steels—All users of steel of the 5 per cent chromium, 0.45-0.65 per cent molybdenum type will be interested in an article, Bulletin 3-266, giving the results of an investigation of the effect on creep strength of increasing the molybdenum content. The Babcock & Wilcox Tube Co.

24—Metalizing Process—A new 16-page booklet on the Metallizing process, giving information on the new MOGUL Model "P" and "S" Metallizing gun, together with a 24-page booklet on various Metallizing applications includes a complete history on the aluminizing process which has been used extensively for a number of years to combat oxidation from high temperatures. The Metallizing Co. of America, Inc.

25—Metals—The Working of S.A.E. Nickel Alloy Steels is the title of a new 16-page booklet which covers effects of alloying elements, characteristics and applications, and heat treatment. Practical instructions for machining, broaching, drilling, tapping, threading, milling, sawing, grinding, welding and gas cutting are also included. The International Nickel Co., Inc.

LOW in head room

LARGE in capacity



You'll find the Murray Type "Y" Boiler just the unit to install in cramped quarters. . . Its large steam drum gives liberal steam releasing area for the steam generated. And the boiler is baffled so that the entire heating surface of the main tube bank is exposed to the direct radiant heat of the furnace. . . Write us about your boiler problems.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA, U. S. A.

MURRAY

Electrical Equipment

26—Thermocouples—A 40-page catalog, N-33A(6), lists a comprehensive line of assemblies with parts and accessories, and includes information of general usefulness on the correct choice of couples. Tabulated in easy-to-use form, this information should be helpful to users as a guide to the best choice of couple for the application at hand. Illustrations and listings are so arranged that parts and accessories, as well as complete assemblies, are easily identified. Leeds and Northrup Co.

27—Lightning Arresters—A new 8-page illustrated booklet, R-925, lists and describes the recently announced additions to the line of type LV lightning arresters. Tables showing performance values, and one giving application data, weights, and permissible line to ground voltage when used on different types of circuits are given. Dimensions are presented in sketch form for all eight arresters. Mounting methods are discussed, and the several available mounting brackets are fully dimensioned and described. Westinghouse Electric & Mfg. Co.

28—Motors—This new bulletin, No. B-6002, on large motors and control for heavy duty drives, will be of particular interest to engineers in the steel and mining industries. It shows a large number of installation views of heavy duty motors in operation and covers the design features of these machines. A section on switchboards and control for use with such large rotating equipment is included. Allis-Chalmers Mfg. Co.

29—Indoor Bus Bar Supports—A new 28-page illustrated booklet, Descriptive Data 36-200, describes and lists a complete line of standard indoor bus supports for use on voltages of from 600 up to 23,000 v. Contained are full descriptions, listings, rating data, pictures, and dimensions of the complete line of the Type H, the modified hollow square, and low voltage single unit bus bar supports. In addition to the bus supports themselves, various support clamps, mounting brackets, round conductor supports, and extruded aluminum clamps for indoor channel busses are listed and described with complete dimensions and rating data included. Westinghouse Electric & Mfg. Co.

30—Circuit Breaker—A new 16 page booklet, B-2243, covering the entire line of Westinghouse air and compressed air circuit breakers gives a short history of the development of the air circuit breaker, including the development of the "De-Ion" method of fast and positive arc quenching. Application hints for the various breaker types, including central station, manufacturing plant, heavy mill, transportation, and general building installations are included in the booklet. Westinghouse Electric & Mfg. Co.

31—Distribution Transformer—Bulletin B-6096 tells the story of A-C latest Distribution Transformers as built in ratings of 1½ to 25 kv-a. and standard voltage classes from 2400 to 7620 v. Allis-Chalmers Mfg. Co.

32—Motor Blower—A new Motorblower featuring reliability, quiet operation and low cost is illustrated and described in a new bulletin Form 2626. Ingersoll-Rand Co.

33—Circuit Breaker—A new 12 page illustrated booklet, Descriptive Data 33-700, describes "De-Ion Grid" Type "O" oil circuit breakers designed for indoor service for voltages from 15,000 to 34,000 and for interrupting capacities from 500,000 to 2,500,000 kv-a. Cutaway sketches show the principal design features. Wiring diagrams for two typical breaker controls are shown. Solenoid operating mechanisms are described, and fault clearing speed in cycles is given. A complete table of rating data, shipping weights and oil requirements and dimensions is also included in the booklet. Westinghouse Electric & Mfg. Co.

34—Capacitor—Bulletin No. 190A entitled Capacitors for Power Factor Correction of Fluorescent Lamps presents typical fluorescent lamp circuits with suggested connections for correction capacitors, and tables showing the capacitor values required for different degrees of correction. Cornell-Dubilier Electric Corp.

35—Capacitor—Catalog No. 180X describes high-voltage capacitors for heavy-duty X-ray and impulse or surge-generator applications. A table indicating the maximum operating voltage to which C-D X-ray capacitors may be subjected is included. Cornell-Dubilier Electric Corp.

Diesel Engines

36—Diesel—More than a hundred typical installations of Caterpillar Diesel Engines are photographed and discussed in a booklet entitled On The Job, which gives a broad outline of the general adaptability of the Diesel engine. Caterpillar Tractor Co.

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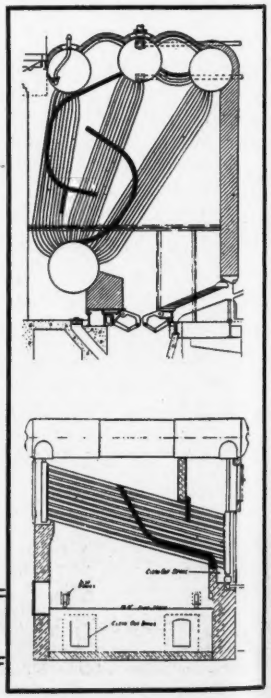

THE ENGINEER COMPANY, 75 West Street, New York, N.Y.

37—**Vibration**—Installation of a 150 hp. 4 cylinder Diesel generator, turning at 720 r.p.m. which was mounted on Korfund steel spring Vibro-Isolators and the new Korfund Vibro-Stabilizers is discussed in Bulletin Ba-22. The Korfund Co., Inc.

38—**Diesel Engine**—A new 8-page bulletin illustrates and describes Caterpillar Diesel engines. Power units, generator sets and marine engines are covered in detail. Caterpillar Tractor Co.

Materials Handling

39—**Conveyor-Elevator** — Catalog No. 140 containing 64 pages contains many additions to the company's previous catalog on the Redler line. Both horizontal and vertical closed circuit Redler units are covered with complete specifications and dimensions. Phantom wash drawings of elevation sections of each of the standard Redler shapes have been included. All dimensions are completely brought up-to-date and the specifications cover the new streamlined design. Stephens-Adamson Mfg. Co.

40—**Loader and Piler**—Bulletin 240 covers the S-A line of box car loaders and pilers—used for loading box cars and piling practically any loose bulk material. Stephens-Adamson Mfg. Co.

41—**Winches**—A new folder, No. 340, covers a complete line of hand and motor winches for lifting and pulling loads up to 3000 lb. Stephens-Adamson Mfg. Co.

42—**Vibrating Screen**—A new 20-page illustrated catalog No. 1762 illustrates and describes Link-Belt vibrating screens for screening of a great variety of materials. Link-Belt Co.

Miscellaneous

43—**Bearings** — This 96-page catalog contains dimensional data on all types of ball bearings, tapered roller bearings, straight roller bearings, thrust bearings and ball bearing pillow blocks. The mounted bearing section also includes machine units, flange mountings, take-up units and hanger bearings. The engineering section contains information that designers and maintenance men alike will find useful. Ahlberg Bearing Co.

44—**Hydraulic Products**—This book is a combination catalog and Use manual, illustrating many new products and applications which have never before appeared in print. The products include Hydraulic Hand Jacks; Gage-equipped Jacks; Wheeled Floor Jacks; High-Pressure Valves; Remotely Controlled Jacks, both hand-operated and motor-driven; hydraulic tools for maintenance and production; and hydraulic pipe and conduit benders. Blackhawk Mfg. Co.

45—**Hose Mask**—A new descriptive bulletin, No. EB-4, dealing with the application of the All-Vision Facepiece and a complete line of Hose Masks, includes the combination, utility, standard and special hose mask models. Mine Safety Appliance Co.

46—**Regulator News** is the title of a new company publication to appear six times a year. Of interest to utility executives and engineers, it will treat exclusively of problems pertaining to feeder voltage regulation. Allis-Chalmers Mfg. Co.

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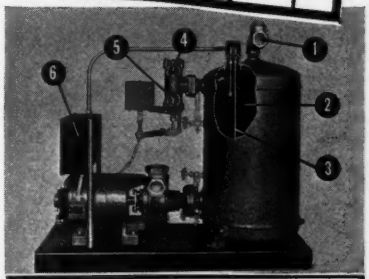


The "Pressure equalizing" Principle

Condensate enters inlet (1) filling equalizing chamber (2) until water across electrodes (3) completes circuit to relay (6) which operates two way valve admitting steam from boiler through inlet (4) to equalizing chamber and simultaneously starting pump. When contents are pumped into boiler, inlet (4) is automatically closed, pump is simultaneously stopped, and steam is exhausted to receiver through port (5).

Johnson *"Pressure Equalizing"* BOILER FEED PUMPS

Power Plant Construction News

Calif., Los Angeles—Los Angeles Water and Power Bureau, 205 South Broadway, will receive bids until Aug. 15 for new high-pressure boiler unit for installation in municipal steam-electric generating station in harbor district, Wilmington, to have a normal rated capacity of 570,000 lb. of steam per hr., with 2-hr. overload capacity of 675,000 lb. per hr., delivered and installed complete, ready for operation (Specifications 3450).

Conn., Norwalk — Ericsson Screw Machine Products Co., Inc., 25 Lafayette Street, Brooklyn, N. Y., plans installation of electric power equipment in new one-story plant on Boston Post Road, Norwalk, where site has been selected. Entire project reported to cost about $75,000. Proposed to begin work soon.

D. C., Washington—Quartermaster General, United States Army, Washington, plans new steam-electric power plant service at Alaskan Air Base, Anchorage, Alaska. Work will be carried out in connection with an authorized appropriation of $11,777,000 for buildings and facilities at that point.

Ill., Aurora—Oatman Bros., Inc., 151 Middle Street, milk and dairy products, plans installation of electric power equipment in new two-story and basement plant on local site on Prairie Street. Bids are scheduled to be asked in August. Entire project estimated to cost over $120,000. E. E. Roberts & Elmer C. Roberts, Inc., 82 West Washington Street, Chicago, Ill., is architect.

Ill., Chicago—Bartlett Trailer Corporation, 3830 South Michigan Avenue, plans installation of electric power equipment in new plant at Archer and Ashland Avenues, consisting of two one-story units, 72x280 ft., and 72x100 ft., respectively. Entire project reported to cost over $80,000. Charles C. Henderson, 134 North La Salle Street, is architect.

Iowa, Waukon—City Council, Waukon, has plans maturing for new municipal power station, using Diesel engine-generator units and accessories. Cost estimated close to $275,000. Financing is being arranged. Hubbard Engineering Co., 415 North La Salle Street, Chicago, Ill., is consulting engineer.

Iowa, Woodbine — City Council, Woodbine, will receive bids until Aug. 5 for new municipal power plant, including three Diesel engine-generator units, with capacity from 600 to 750-b.hp., oil storage tank, switchboard and auxiliary equipment. Also for electrical distribution system. A. S. Harrington, Baum Building, Omaha, Neb., is consulting engineer.

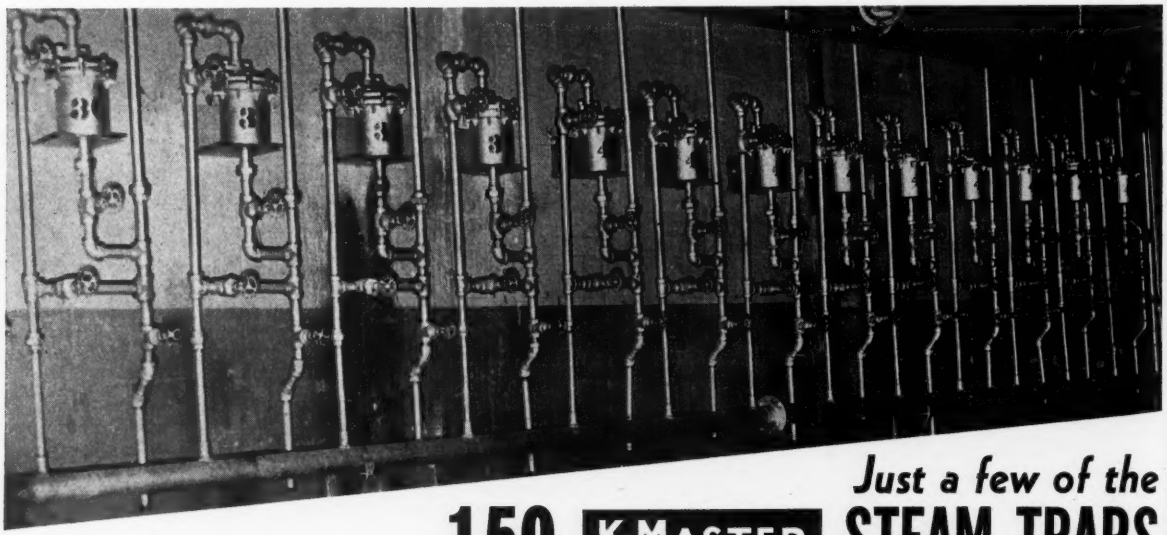
Ky., Lexington—Kentucky Utilities Co. has plans under way for new steam-electric generating station on local site for which appropriation of about $4,000,000 is being arranged. Installation will include turbine-generator units and accessories, high-pressure boilers and auxiliary equipment. Completion is scheduled in 1941. Project will include extensions and improvements in transmission and distributing lines.

Ky., Madisonville—City Council has preliminary plans under way for new municipal power plant. Surveys and estimates of cost are being made by Burns & McDonnell Engineering Co., 107 West Linwood Boulevard, Kansas City, Mo., consulting engineer.

Mass., Ashland—Warren Telechron Co., Ashland, has plans under way for addition to boiler house at electric clock-manufacturing plant, with installation of new boiler unit and auxiliary equipment. Company is a subsidiary of General Electric Co., Schenectady, N. Y.

Mich., Detroit—Detroit Diesel Engine Division, General Motors Corporation, Outer Drive and Pere Marquette Railroad, plans installation of electric power equipment in new one-story addition, 280x600 ft., to plant, used for production of small Diesel engine units. Capacity of present central-heating plant will be increased. Entire project is reported to cost over $400,000.

Mich., Iron Mountain—City Council has preliminary plans in progress for a municipal light and power plant. Burns & McDonnell Engineering Co., 107 West Linwood Boulevard, Kansas City,



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Mo., consulting engineer, has been engaged to make surveys and estimates of cost.

Miss., Hattiesburg — Hattiesburg Creamery & Produce Co., plans boiler house in connection with new creamery and milk products plant on Walnut Street. Entire project reported to cost over $60,000. T. Roscoe Hearon, Hattiesburg, is architect.

Miss., Meridian—People's Water & Gas Co., Meridian, M. T. Ivey, vice-president, plans new compressor plant in connection with extensions in natural gas pipe distribution system. Fund of about $140,000 has been arranged for entire project. Proposed to carry out work soon.

Mo., Nevada—City Council is arranging a special election to vote bonds for proposed municipal power plant. Surveys and estimates of cost were made a number of months ago for 1500-kw. capacity station, estimated to cost about $450,000, by William Spann, Interstate Building, Kansas City, Mo., consulting engineer. Proposed to carry out project in fall.

Nev., Pioche — Combined Metals Reduction Co., Felt Building, Salt Lake City, Utah, E. H. Snyder, vice-president, plans installation of power equipment in new reduction mill at Castleton mining properties, near Pioche. Entire project is reported to cost over $500,000.

N. Y., Lockport—Harrison Radiator Corporation plans installation of electric power equipment in new two-story addition to automobile radiator-manufacturing works, about 245x350 ft. Proposed to begin work at early date. Entire project reported to cost over $175,000. Company is a unit of General Motors Corporation, Detroit, Mich.

N. D., Grand Forks—Minnkota Electric Power Cooperative, Inc., Grand Forks, has plans under way for new electric power plant, for power service for rural electric system. Fund of about $850,000 has been secured through Federal aid for new station and certain line construction. Proposed to carry out work soon.

Ohio, Akron—General Tire & Rubber Co., East Market Street, plans installation of electric power equipment in new five-story addition to automobile tire and tube-manufacturing mill, on which work is scheduled to begin early in fall. Entire project will cost over $200,000.

Ohio, Columbus—Kraft-Phenix Corporation, 500 North Peshtigo Street, Chicago, plans boiler house at new branch plant at Columbus, where site is being selected. Company will lease buildings to be erected by local interests, headed by Theodore Schirtzinger, 1291 Ashland Avenue, Columbus. A cold storage plant will be installed. Entire project is reported to cost over $60,000. Proposed to begin work soon.

Pa., Ambridge—American Bridge Co., Frick Building, Pittsburgh, Pa., plans installation of electric power equipment in new shop for steel barge construction at plant at Ambridge, on Ohio River. Entire project will cost about $1,000,000. Work will be placed under way soon.

Tenn., Chattanooga—Tennessee Gas & Transmission Co., Inc., 401 Chattanooga Bank Building, John E. Buckingham, secretary and treasurer, plans series of compressor plants in connection with new welded steel pipe line from natural gas field area of Northern Louisiana to Chattanooga, Nashville, Tenn., and vicinity, to be used for booster service for gas transmission system. Surveys are in progress. Entire project reported to cost over $2,500,000.

Wash., Aberdeen—Polson Lumber & Shingle Co. plans installation of power equipment in connection with rebuilding of mill recently destroyed by fire, consisting of several one-story structures for sawmill, shingle mill, planing mill, etc. A new power house is planned. Loss estimated over $400,000, with machinery.

Wash., Seattle—Boeing Aircraft Co., 7901 East Marginal Way, has approved plans for new steam power house at airplane-manufacturing works, 35x78 ft., to be used for service at Plant No. 2. Cost over $50,000, with boiler units and auxiliary equipment. Work will be placed under way at once.

W. Va., Morgantown—E. I. du Pont de Nemours & Co., Inc., duPont Building, Wilmington, Del., plans installation of electric power equipment in proposed new chemical plant near Morgantown, where tract of about 800 acres of land is being secured. It will comprise several large production units. A power house will be built. Entire project reported to cost over $1,500,000.

Wis., Madison—Deere & Co., Moline, Ill., plan installation of electric power equipment in new one-story agricultural implement-manufacturing plant at Madison, 120x230 ft., on which work is scheduled to begin soon. Entire project will cost over $125,000.

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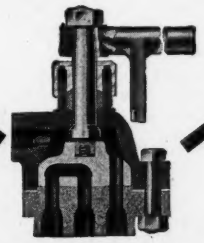

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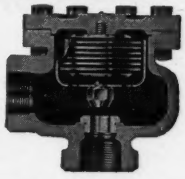

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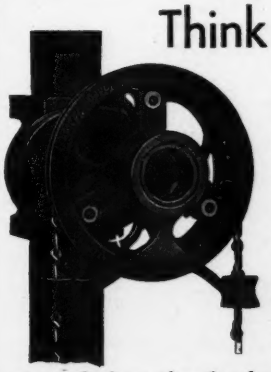

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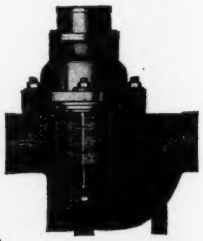

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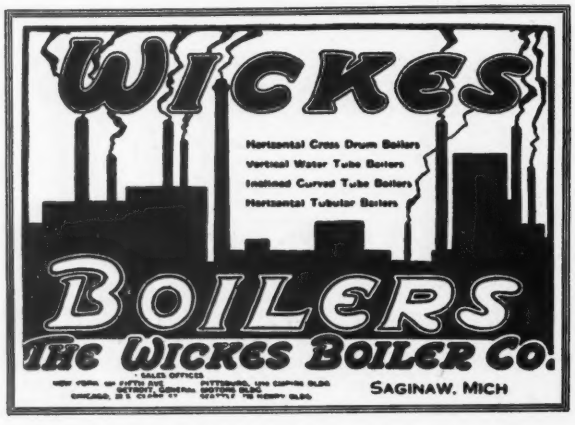

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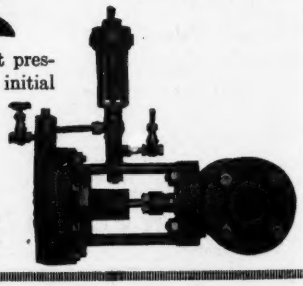
Will maintain the constant pressure desired regardless of initial pressure. It is a dead end valve.

May we send catalog E-10?



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